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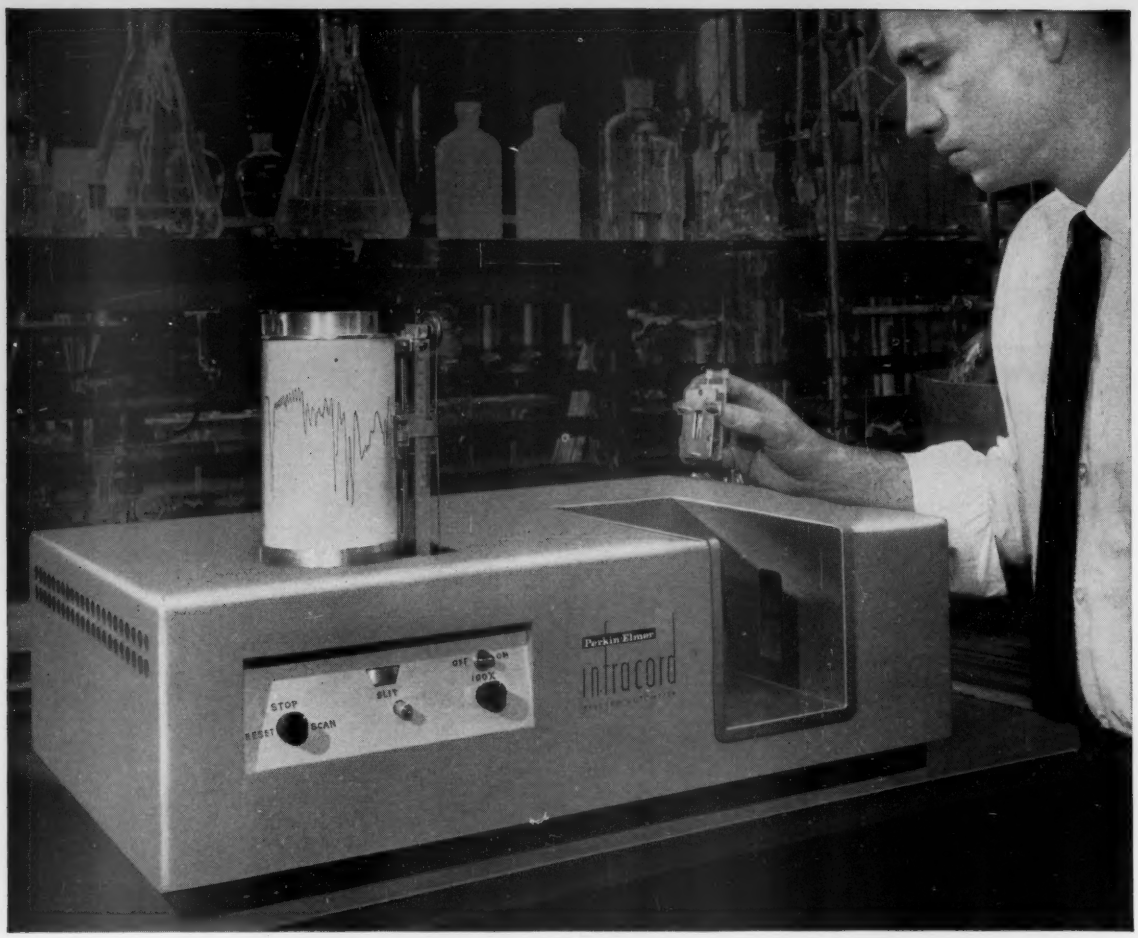

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Information about the Kodak X-Omat Processor is given out by Eastman Kodak Company, Medical Division, Rochester 4, N. Y. It processes all standard sizes of sheet film in any order, from 5" x 7" up. Twenty 5" x 7" sheets per minute is typical of the capacity. Doesn't have *to be x-ray film, we suppose.*

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Ozone is a noxious gas. (The man in the street, if he recognizes the word "ozone" at all, congratulates himself on knowing it to be a high-toned synonym for pure, invigorating air. When he hears that ozone is being used as an index of urban air pollution, he is confused, poor fellow—all the more if he is bright enough to remember from high school chemistry that ozone is O_3, nothing but oxygen.)

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This is one of a series of reports on the many products and services with which the Eastman Kodak Company and its divisions are . . . *serving laboratories everywhere*

Kodak
TRADE-MARK

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SCIENCE

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An Academic Question

In its classical formulation, the problem of *laissez faire* versus governmental spending and planning has been limited pretty much to economic matters. But the past 15 years have seen a considerable increase in the public funds devoted to scientific research and a growing concern with the place of science in public education. Consequently, the problem of the role of the state in the affairs of the individual has, in effect, been broadened to include the Government's responsibility to science.

Before attempting to define this responsibility, it is important to be clear about the actual enterprise toward which the public interest is presently directed. Unfortunately, a wish to manipulate the course of nature does not necessarily imply a wish to understand the natural laws upon which such control is based. To the consumer of scientific knowledge, that is to say, to the man who rubs the lamp and commands the jinni, the achievements of science are nothing more nor less than feats of magic. The various agencies devoted to science might just as well be given such titles as the National Academy of Magic, the National Magic Foundation, and the American Association for the Advancement of Magic, and one of the most pressing problems of the day might just as well be the shortage of magicians.

The time is past when one may speak of disinterested research, of scientists following the argument wherever it leads. We have all learned that sooner or later research leads to wealth and power, if not for scientists themselves, then for others. But today, as in the past, scientists are often motivated by a somewhat different set of values. Unfortunately, to explain, say, intellectual curiosity to someone who does not have it is not easy. The delights of research are likely to sound as unconvincing as the claim that virtue is its own reward. But if such explanation is difficult, scientists at least share this difficulty with poets, artists, historians, humanists, and other persons.

In an age when magic is at a premium, there is a tendency to see the Government's responsibility to science in terms of what science can do. With our national security under constant threat and with the general welfare usually understood to mean material welfare, it may be an academic question to introduce another viewpoint. But we suggest that, in addition to its responsibility to magic, the Government has a responsibility to science, and that this responsibility extends to other enterprises of culture and scholarship.—J. T.

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Structure of Physical Science

Jerrold R. Zacharias

On reading the title given to this symposium, "Fundamental units and concepts of science," my first intention was to make a rather general presentation of the basic problems that confront the physical scientist—the physicist, the astronomer, the chemist, the geologist. But I am not a specialist in generalities, and I fell into an obvious trap. If you ask a man who works on units about units, he will very likely tell you about units. I made a draft of a paper on this subject and sent it off to our major and distinguished commentator, Michael Polanyi, and I received the following reply: "My first impression of your contribution is that, by contrast with the biologists and sociologists, you are not worried at all about what you are doing in science." I took this comment to mean that Polanyi did not want to hear about units. And I am only too happy to agree with him, provided that he allows me to use my favorite motto. It is the moral from one of James Thurber's *Fables for Our Time,* and it goes, "It is better to know some of the questions than all of the answers."

Nonetheless, I regard it as something of a pity that I am not going to talk about units and standards. I have either the great fortune or the great misfortune always to be interested in what I am doing, and at this time in my life I am working on standards of time. I would like nothing better than to address a captive audience on the fine, basic scientific questions that might be answered by intercomparisons of various kinds of clocks. Similarly, it would be entertaining, to me at least, to discuss the significance of a quantity called "the velocity of light." Although, at the moment, there seem to be no measurements which show that "the velocity of light" is varying from year to year, I regard it as of some importance to try to understand the significance of the questions that such a variation would raise. The velocity of light is now known to only about 1 part in a million. There are at present groups of experimenters who are trying to improve this precision by some orders of magnitude. In fact, I believe that it will be possible to obtain, within the next decade, a precision of 1 part in 10^{12}, or 1 part in a British billion. But this kind of thing is not appropriate to this occasion, so let me leave it.

After some preliminary discussion, I want to arrive at a simplified description of what I consider to be the basic problems that confront the physical scientist, qua scientist. I am carefully avoiding all the problems that confront him as a technologist, as a citizen, as a humanitarian, as a philosopher, or even as a teacher of the young, although nothing would give me more pleasure than to talk about what some of us are doing to try to make teaching physics in the secondary schools a bit easier and a bit more effective.

Particles and Forces

As for these basic principles, it will be helpful first to establish a pattern in which the subject of physics and its closely associated sister sciences fall. This is especially so because one can describe such a tidy package. We consider (i) the particles that are involved; (ii) the laws of force that these particles obey; (iii) the laws of motion that result from the interaction of the particles with these forces; (iv) the mathematical calculations that permit (v) the experimental observations that can be compared with the theory in order to see whether the particles and the laws of force and laws of motion are appropriate to a description of nature. In order to clarify this framework, let me apply it to some well-known cases.

One of the oldest, simplest, and most beautiful examples exists in that branch of astronomy which deals with our solar system. This particular instance may be regarded as a prototype of most of the problems of physical science. The sun and its planets and the satellites of the planets are the particles. Newton's law of gravitation is the law of force. Every particle in the universe attracts every other particle with a force which is proportional to the inertial masses of the particles and which varies inversely with the square of the distance between them. Newton's law of motion predicts where the particles will go, given a knowledge of where they were at some earlier time. And, with modern computing machinery, it is now possible to compare observations on planetary and lunar motions with theory. In fact, lunar motions can be predicted to about 1 part in 10^9, which until recently was considered admirable.

At the risk of laboring what is well known, let me point out that the explanation of the motion of the planets by the laws of gravitation and the laws of motion makes a superb example of that round-robin process which is characteristic of science. In first approximation, the particles involved (the sun and the planets) *were* known, and the gravitational law of force and the Newtonian law of motion yielded predictions that were correct within the limits of observation. Subsequently, more refined measurements, of course, led to the discovery of unknown planets. In addition, Einstein's modification of Newton's law of motion has been found to be necessary for describing a slight perturbation in the orbit of Mercury. So far, the law of gravitation appears to be holding up well, although I am willing to bet that the next decade will see considerable discussion of the law of gravity, not the least provocative of which will be the ques-

The author is professor of physics at Massachusetts Institute of Technology, Cambridge, Mass. This article is based on the first paper presented at a symposium, "Fundamental units and concepts of science," that was held 27–28 Dec. 1956 during the New York meeting of the AAAS.

tion of the gravitational effects of antimatter.

Take another example, the structure of atoms and molecules. The particles are the atomic nuclei and their circumambient electrons. The forces involved are all manifestations of Coulomb's law. Like charges repel, and unlike charges attract each other with a force that varies inversely as the square of the distances between them. (One may remark here that, in *all* of atomic and molecular physics, in *all* solids, liquids, and gases, and in *all* things that involve our relationship with our environment, the *only* force law, besides gravity, is some manifestation of this simple law. Frictional forces, wind forces, chemical bonds, viscosity, magnetism, the forces that make the wheels of industry go round—all these are nothing but Coulomb's law, as simple as the force at work when you pick up a piece of paper with a fountain pen that has been rubbed on your sleeve.) Of course, the laws of motion are not those of Newton but are the wave mechanics of Schrödinger, Born, Dirac, and Heisenberg. Unfortunately, even the best computing machines are still having trouble with all but the most simple systems. The mathematical problems of the hydrogen atom, with only two particles, can be solved with great precision. So far, the more complicated problems of atoms heavier than hydrogen and of molecules of liquids and of solids yield to degrees of precision that suffice only to test the adequacy of the mathematical methods. Laws of nature that apply to all matter and to all radiation rarely emerge from a detailed consideration of systems importantly involving more than two particles at a time. Of necessity, the Pauli principle is an exception, and so, too, are those cases in which there is enough chaos to make things simple again.

The next example is that of the atomic nucleus. We believe that we know what particles are involved—we talk of protons and neutrons in the nucleus. We admit that, with some provocation, other particles can be emitted by a nucleus—electrons and antielectrons; neutrinos and antineutrinos; mesons, plus and minus; pions, plus, minus, and neutral; heavy mesons; hyperons; and so on. But there is evidence that, most of the time, protons and neutrons make a good first approximation to the particles.

Basic Principles

Let us look first at the laws of motion. The quantum mechanics, so beautifully formulated for atomic problems, is probably appropriate for considerations of the motions inside the nuclear core. To be sure, extremely relativistic forms are required because the energies of the particles are large. One cannot regard the velocity of light as arbitrarily large. But the logical structure of the wave mechanics has made such profound philosophic changes in scientific thinking that we hesitate to give it up. Besides this, some of the features of the quantum mechanics which make it so different from Newtonian mechanics have been shown to hold for atomic nuclei.

We know very little about the details of the essentially nuclear forces. Even though we have much quantitative knowledge about the interactions in "two-body" problems like that of the deuteron and the scattering of one nuclear particle by another, we are in trouble with the many-body problem. Nuclear forces are so strong that nuclear material has a density of 10^{14}. The individual nuclear particles are so close to each other that we not only have mathematical difficulties, but we also have no assurance that the proximity of other particles leaves the interaction between pairs the same as it would be out in space. In summary, the short-range forces between particles (what we call nuclear forces) remain a challenging unknown.

However, there are other ways of looking at things so that they are not such a tidy package. So far, the idea of physics, and the ideas that are basic to the formulations of chemistry and the related sciences, depend essentially on the notion of force between particle pairs—the sun and the earth, the nucleus and the electron. For more complicated problems, we always assume that a third body may affect the positions of two others, but we have not yet made the bold assumption that the presence of a third body affects the type and magnitude of the forces between the first two. Let me state the general question this way: Are there physical effects of a new sort that arise simply from the existence of large aggregates of particles? Certainly this notion is elementary to the sociologists. Does matter in a high state of aggregation—as in atomic nuclei, as in the interiors of dense stars, as in solids or liquids even—behave differently from matter in the tenuous states? Certainly people do.

Yet another kind of problem faces us: the nature of a particle at very close hand—any particle, the whole zoo of fundamental particles that have come to occupy the attention of so many physicists in the last few years. There are two ways of stating this problem. One is to say that for forces that vary rapidly with the distance away from a point, the energies increase indefinitely as the distances become smaller. In the case of Coulomb force, we have, to be sure, a *gentle* logarithmic approach to infinite energy, but it is nonetheless troublesome. Another way to say it is that one uses mathematical point-functions in the problems of atomic physics and that the wave nature of everything gives less and less meaning to point positions. During the last 10 years there has been a continued precision approach to this problem, carried out by Lamb, Rabi, Kusch, Bethe, Weisskopf, Schwinger, and many others. But more spectacularly, there has been the approach of superhigh-energy physics, and when the smoke of battle clears away and the properties of the *new* particles are as well known as those of the old ones, we may have a better picture of a single particle.

The last problem I want to talk about is one that has baffled all of us since early childhood. What is the nature of matter and of radiation at points very remote from us, either in space or in time? What happens to light that we shine up into the sky? Where do those neutrinos go, which are manufactured in such profusion by all of the stars? Such questions give me the same visceral feelings that I experience when I contemplate infinity. For some reason that I do not understand, projections into the indefinite past always seem to be more emotionally charged than projections into the future.

Conclusion

Probably not more than 5 percent of professional physical scientists are working on direct attempts to formulate laws with such broad general applicability. Rather, they are finding out how to apply laws to special problems—molecules, simple and complex; solids, and liquids. In a similar way, nuclear physicists are spending most of their time on the properties of nuclei of mass greater than 2. I am sure that all of us—I know I do—work on such complicated problems.

In order to clarify, in case there is any doubt, I may cite some examples of the general and the specific. Snell's law—the law of refraction—and Ohm's law are properties of specific kinds of materials, whereas Coulomb's law and Newton's laws are properties of all matter.

We have found that frequently this important and not very subtle difference is lost in most of elementary physics teaching, and since I have never heard much discussion of this idea by the biologists or sociologists, I wonder whether they have their own way of saying these things. There certainly are statements of general laws.

I regard the doctrine of noninheritance of acquired characteristics as such a law in biology.

In sociology, the much-abused law of Malthus is also such a law. It is the trivially obvious one that we live on a finite sphere, and it voices the heartening optimism that man's technical skill to live will outrun man's technical skill to kill himself. In 1956 we seem to be in the less pleasant phase, but that phase must some day pass and Malthus will be right.

Units and Concepts of Biology

R. W. Gerard

In this conference, which is concerned with the concepts and units of all science, my assignment is the sector of biology. The goal is thus set to consider the life sciences in the context of all science—to compare and contrast, with attention to both similarities and dissimilarities. An approach that is too general will lead into the problems of philosophy; one that is too particular, to the separate subdisciplines. Attention to the sector boundaries, or junctions, thus seems the most efficient, and I shall therefore emphasize the boundaries between physical and biological science and between biological and social science. Since the former boundary has had far more attention than the latter, and since differences have been noted more vividly than have similarities, my emphasis is on biosocial comparisons, a topic that has occupied a portion of my effort in recent years (*1*, *2*).

Entities

It is not chance that the cleavage between natural and social science is greater than that between the sectors of natural science; it is a cleavage between substance and action, body and soul, the objective and the subjective. Inquiring man scans the universe with his sensory end organs, orders and classifies the information thus obtained, and so imposes a structure on the world he recognizes. Here is William James' "blooming, buzzing confusion"; here, in Henry Adams' figure, is man "on a sensuous raft adrift in a supersensuous sea"; and here is the impact of Kronecker's dictum on mathematics, "God made the integers, man did all the rest." Some inhomogeneity must exist for man even to be, and emphatically for him to divide his world into classes. And, since man depends mostly on visual information (two-thirds of all the nerve fibers that enter the human central nervous system come from the eyes), and since the eye detects primarily patterns of spatial extension, man first sees his universe as a collection of material objects. An entity is distinguished from its ground and, given appropriate duration, an individual is born to the perceiver. This is the basic event.

The individuals that people man's primitive world are necessarily commensurate with his own dimensions, his sensory range, and his time span; indeed, they even seem to conform to his status as a living being, for they are strongly personified. As technology offers instruments that reveal the lesser and the greater, as man's senses are extended (and mainly, again, his vision), new entities engage his attention; but this is a later development (*3*). More immediately, various observed individuals are recognized as having some common attributes and so as being amenable to grouping or classifying. This is the taxonomic stage of knowledge, and it follows the stage of simple observation and description just because differences are more likely to command attention than are likenesses (*4*). Man thus types his observed concrete entities into sets and, as the second abstraction (the first being entity from ground), draws sharp boundaries about them.

But, as Whitehead well said, "Nature doesn't come as clean as you can think it"; and, with growing sophistication, man replaces his plateaulike typology with the graded slopes of a probability distribution in a population of nonidentical individuals. A mere collection of seemingly unrelated entities is first given meaning or pattern in terms of perceived similarities; only later is it possible to look more closely at the individuals and to reintroduce differences, but now ordered differences with significance to the larger whole. Moreover, once the initial integration (or induction) has been achieved, progressive differentiations (and deductions) can be meaningful, and subclasses can be conceived and identified, later to become graded subpopulations. This is a sign of growing familiarity with the entities of attention, indicating more interest and ordering and leading to subdivision of effort, or to fragmenting of science. Attention to a subject matter reveals finer differences and new attributes, first of whole individuals and then of their parts and structure, calls for new words to characterize these, and adds new digits to a decimal number as subclasses and sub-subclasses become significant. Here knowledge is in the morphologic stage.

So far, we have considered primarily material entities and their grouping on the basis of sensible, mainly visual, attributes. Clearly, animate and inanimate objects are more alike than are objects and the behaviors of objects; so the physical and life sciences, concerned (as a first approximation) with these two types of object, are closer to each other than they are to social science, which is concerned (still as an approximation) with the behavior of one variety of animate object. But the real shift here is from a focus on organization to a focus on action, from being to behaving, from form to function, from pattern to process, from the timeless to the temporal. "Being" is the cross section of an entity in time, and those aspects of the organization which appear relatively unchanged in a series of such instants constitute the essential structure of the entity or organism. Invariance in time helps to identify the significant units of a mature system. Conversely, along a longitudinal section in time appear the transient and reversible changes, often repetitive, that constitute "behaving" or functioning, and the enduring and irreversible changes, often progressive, that constitute "becoming" or developing. And with this shift in orientation to time there occurs a shift in the entity of concern—from an object, a pattern of matter in space, to a behavior, a pattern of events in time.

Let me briefly recapitulate. Man's attention is first drawn to particular objects in his experienced world. These objects are grouped into classes and subdivided into components, at first with Procrustean rigidity and later with more freedom of variance, and then interest shifts to particular processes. But, as a group is more removed from concrete prehension than are its component entities—a species seems more abstract to us than does an individual organism—and as its component entities become more or less interchangeable, so is a process more abstract and universal than are the acting objects. Permeability, to some thing—ion, gene, idea, person—and in some degree, is a property of all boundaries (indeed, a boundary may be characterized as a zone of lowered permeability), as irritability, quantified as a threshold to some environmental change, is a property of all responsive systems.

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This shift in approach is like that from phenotype to genotype or that from observation to model building.

For study of permeability or irritability, the particular system examined is not initially so important as is what is done with it, and the common denominator shifts from the object to the variable. Some attribute of the object is selected for attention and measurement as the object is manipulated. New methods arise, experiment dominates observation, and changes of the observable in time are almost universally examined. Not the nerve but the nerve impulse is the entity of concern, and this can be studied on any particular nerve that comes conveniently to hand. True, important differences appear between impulses in invertebrate and vertebrate nerves, in nerves of the frog and man, and even in separate fibers of a single nerve; but these differences are mainly quantitative ones in the same parameters. Indeed, the behavioral similarities are so significant that eventually a functional criterion may help to define a material set: a nerve cell is one that conducts an impulse, and a smooth muscle cell is sometimes best distinguished from a connective tissue cell by its ability to contract. This is the essential shift from the morphologic to the physiologic mode. It must not be forgotten, however, that manipulation remains limited to the material object: the influence of temperature on conduction rate is determined by warming a nerve, not a nerve impulse; the answer to the question, Did you ever see a dream walking? is *No*.

The pure morphologist, then, is concerned with the structure of particular objects and attempts to make his description ever more complete. Here is the gross anatomist and naturalist of the past as well as the old organic chemist describing a substance or the visiting anthropologist describing a village. (The electron microscopist or cytochemist or ethologist of the present, as well as the modern macromolecule chemist or the factor analyst seeking primary abilities or the sociometrist noting contacts or quantifying opinion, is often busy with the specific case but is usually concerned really with the class.) He observes what is; and he seeks ever more powerful tools to identify a system and fix it at an instant of time, to reveal its finer detail, to discriminate its more subtle differences, and to do this more precisely on more limited samples. His concern is primarily with the individual instance, like the clinician's with his patient, the humanistic historian's with his character or period, the artist's with his poem or painting or other unique creation of man. When a class property becomes the focus of interest, comparative studies replace those of the individual, and descriptive morphology gives way to comparative morphology or systematics or physiology or genetics or some other discipline concerned with relation or function or development. As the class or property replaces the individual—as the actuarial approach replaces the clinical approach—there is greater distance between the operator and his material, the material becomes more objectified—not Tabby, but a cat; not John and Mary Smith, but a family—and analysis is added to description.

The entities or units which are significant, which are invariable (organization) or repetitive (function) or progressive (development) in time, similarly shift from concrete material entities to abstracted properties of classes of material entities (*5*). It is an interest in such attributes as personality traits or social roles and connections as the units of structure (aside from personal behavior and role-playing as actions), rather than in the individual or groups that exhibit them, that makes some aspects of social science seem different from life science.

Levels

An entity of interest, then, may be an object or some property of it or a class of objects or some property of the class. But the class is, of course, a kind of individual; and the more the members of the class interact—even to the extent of developing into differentiated subclasses —rather than coexist, the more does the superordinate group become a true individual rather than a collection of ordinate individuals. The shift from separated cells to a reproducing body, shown by the slime mold, remains an excellent example of such individuation; a species with interbreeding individuals determining the properties of its gene pool is a continuing superordinate individual. This is the now widely accepted relation of hierarchy and levels (*6*). The atom, an individual or unit, is built of subordinate differentiated and interacting units, the various nucleons and other ultimate (for the moment) particles, and is built into a superordinate molecule. The individual molecule, in turn, with like or unlike fellows, becomes a crystal or a colloid or some other material aggregate; the colloids form particulates; these, cells; cells, tissues and organs; these, organisms; and organisms, species and larger taxonomic categories, or, in another way, groups, communities, and larger ecosystems. I have found the word *org* convenient for those material systems or entities which are individuals at a given level but are composed of subordinate units, lower level orgs, and which serve as units in superordinate individuals, higher level orgs (*7*). The important levels are those whose orgs (entities) are relatively enduring and self-contained. Thus, a cell is more likely to continue as an individual maintained entity than is a given colloidal micelle or a cell particulate, and an organism will vary less in time than will its parts or organs.

In the course of cosmic evolution, assuming a start in chaos, orgs at a given level become more highly integrated—with a clearer boundary, with more differentiated and interdependent units, and so with a more complex structure and more powerful regulating mechanisms—and new levels are superposed. But each added level permits the combination of old level orgs, now subunits of the new org, in various ways. It is because of the explosive increase in richness of pattern with rise in level that there appears to be an emergence of unpredictable novelty. The particular org that forms is indeed understandable in terms of the units, and their relationships, of which it is built; in this sense the situation is reductionist. But the particular org and its properties are rarely predictable a priori, because of the great number of possible outcomes, with either known or unknown probabilities and with that strong dependence on unspecified values of unidentified conditions which we call chance.

Thus, higher level orgs are likely to have a greater variety than lower order ones, and they are likely to depend more on their particular past; they are more individual. But they are also less plentiful, since several subordinate units contribute to each. A handful of ultimate particles form a hundred species of atoms, or perhaps a thousand, noting isotopes, and a hundred kinds of atoms form millions of molecular species. But the total of molecules is less than the total of atoms, and the total number of members of an average species of molecule is far less than of the average species of atom. The kinds of living organisms compoundable from the subpopulations of atoms and molecules (and combined or macromolecules, as nucleoproteins from amino acid and nucleotide building blocks) must be infinite in any meaningful sense; and the groups compoundable from organisms must be even more so. Yet the number of members of each kind of organism is vastly less than of each kind of molecule; and of groups, again less. In fact, whether from insufficiency of material or of time, the actually realized species or organisms are probably fewer than those of molecules (certainly they will be with the creative meddling of synthetic chemists); and the realized groups or ecosystems or societies, far less again.

Certainly all realizable molecules or cells or organisms or groups have not been realized, and the null members are not distributed at random. Particular combinations, orgs, are more stable in a given environment than are others, and these will be "successful"—that is, will occur in larger numbers—while that environment lasts. Furthermore, individual orgs form sets, as species form genera (and elements thus fit into columns of the Mendeleev table); molecules divide as to ionization or polymerization or what not into inorganic, organic, and macro molecules; organisms classify into kingdoms and phyla and down, because of a kind of periodicity in the patterns of formation. And, the grandest dichotomies of all, the hierarchy of levels has branches. The physics of atoms is unitary. The chemistry of molecules is strained between inorganic and organic and bio but still retains a unity.

At the next level, however, is an unquestioned split into the complex inanimate orgs of geology and astronomy (and meteorology and oceanography, perhaps even of architecture and engineering) and the complex animate orgs of biology. Physics and chemistry thus are subordinate to biology, the earth sciences coordinate with it; and in many ways the earth sciences are more comparable to biology than are the former. The entities of concern in biology and the earth sciences, as compared with physics and chemistry, are more individual and there are more species of them to deal with; and as unique orgs at the supermolecular level they are closer to ourselves, are more a subject (*thou*) than an object (*it*).

In the domain of biology between the cell and the multicellular individual, the tissue is an org with cell units, and so also is an organ. The first is a population, with cells related by origin or history, and a loose org; the second is a tight well-integrated org, with cells related by function. The same threads extend beyond the individual—to species and larger population categories, based on descent, and to ecogroups of various sizes and levels, based on fundamental interrelation. Moreover, above the level of the individual occurs another major branching, with societies—especially but not exclusively of man, or even of any single species—diverging from the population axis. Here population genetics and systematics leave ethology and ecology, and here social science separates from biology. The ecosystem of a lake or forest, or of an ant hill or flock of starlings, is thus coordinate with human spatial and functional groups, the village or the tradesmen, as is the clone with the clan as a lineage group. Again there is a jump in individuality and a diminution in kinds, a greater nearness to man and a consequent shift from object relationship toward subject relationship, at the social level.

Becoming; History

History, or becoming, I said in a preceding section, is a regular change, normally progressive, in a system along the time axis; function, or behaving, is a repetitive perturbation along this secular trend; and structure, or being, is the instantaneous status. The units and subunits of an org are nodes of stability, relatively constant in time. These are the structural residues of past action, the molecules or organs or institutions that have become fixed, yet which also carry the cumulative changes of becoming. It is critical, however, that, whatever role process initially played, traces of the past can be carried forward only by concrete material entities, not by abstracted units (*8*). The neurone can evolve or develop by changes in its components, and so the nerve impulse can also change, in speed, intensity, and what not; but the impulse, per se, does not develop; it is a single action and has no history. So also, the individual person—or generations or groups of persons—carries the history of a society, even though the role or status is the unit of interest. And, of course, the gene—or generations and arrays of genes—carries the heredity of the organism and the population. It is well to note, to prevent confusion, that secondary material products of the primary entities may also be carriers of the information and ordering, the amount and kind of matter, which the past imposes on the present—wooden vascular tubes, seed cases and egg albumen, chitin or bony skeletons, elastic fibers and plasma antibodies, nests and burrows, buildings and machines, books and recordings, are examples—but these separate material carriers only reemphasize the point.

In the becoming of a given entity, there may be a shift in emphasis from one carrier of the past to another, and the shift is normally up the hierarchy levels. A gene, if it is a nucleoprotein molecule, is the product of vast chemical adventures, from the formation of atoms and simple molecules in the distant past of its ancestral lineage, to relatively minor shifts in kind or arrangement of atom or radical, the mutations of its macromolecular maturity. The cell is directed in its development, first by the information stored in its genes, later by the structures and substances that have been formed partly under their influence—reduplicating particulates, somatic mutations, adaptive enzymes, and the like. The organism, in turn, develops by virtue of the various cell types that are differentiated early in its individual existence and their later patterning and other modification as tissues and organs. And the group, finally, changes as its component individuals learn differential roles and skills. It is hardly surprising, then, that higher level orgs are more individualized than lower level ones, that they are more determined by their particular experience, and that they carry a richer and more characterizing past. A society becomes what it is through learning by its individuals, morphogenetic development by their cells, reduplication with mutation by their genes, and so, by regress, into the domain of chemistry.

Attention was focused, in the preceding paragraph, on the units as carriers of the past. Equally essential in shaping each present from its immediate past is the environment acting on the unit. Indeed, at each stage of development of an org, the heredity is fixed in the units entering that stage; and the environment, interacting with these units, leads to new fixations—irreversible changes—in these units or in superordinate ones. Thus, of course, arises the progressive specification and differentiation of orgs, an amorphous totipotentiality yielding to a concrete realization. And the magnificent inventions of gene reduplication and recombination, of heredity and sex, insure stability with variation; as the environment, operating through mutation and selection, insures guided change. At other levels, the mechanisms of becoming are less understood; but there is little doubt that they are similar in broad principle, dissimilar in all else.

Since at each stage and level future development could be along any one of a number of branching paths, depending on the vicissitudes at the moments of decision, the difficult problem is not that of diversity but that of uniformity. More than 40 cell generations lie between human egg and baby, and at each division a slight difference in cell properties or arrangement could magnify through subsequent ones; yet billions of babies have been born within the fantastically narrow range of "normality," only a negligible scattering of monsters outside of it. Of course, too great an abnormality cannot continue its development and is cut off by death; but, aside from such selection, there are self-regulating or homeostatic mechanisms in operation at all times and levels. If enzyme molecules are too active, a fall in substrate concentration and an increase in end-products will slow the reaction. If cells multiply overrapidly, they become too far removed from a source of nourishment and are retarded. If a liver is lagging in its many functions or a nerve trunk is failing to innervate its peripheral field, the structures will grow or regenerate—controlled by still unknown mechanisms—

until performance is adequate. Populations of predators and prey regulate each other in quantitatively predictable ways. And if a man deviates far from the norm of his culture, social pressures and sanctions—by better understood mechanisms than the morphogenetic ones—bring him into line or exclude him. Homeostatic processes nudge orgs toward a uniform state. The interaction of units to form a superordinate org is regulated, as is their action to maintain it.

Behaving; Regulation

This viewpoint has been little applied to the secular changes of long-range becoming, but it is the daily bread of moment-to-moment behaving. The vast bulk of the functioning of any enduring system is as displacement-correcting responses. Here is the negative feedback of engineering or the adaptive or self-regulating or homeostatic response of physiology. All orgs maintain themselves in a dynamic or flux equilibrium by mobilizing internal reserves to oppose environmentally imposed change; or, more rigorously, each unit responds to loads imposed on it by its environment (which may be the superordinate org of which it is part) with responses of its subordinate units that tend to eliminate the stress on the whole, even at the expense of a greater temporary displacement of the part. It is in the particular mechanisms and sequences that different orgs, and especially different level orgs, differ from one another; and each case must be examined individually, as for its structure. Yet here also important commonalities exist.

The organization of an org, its function-structure complex, is investigated by imposing displacements on it. Ordinarily an input is presented, and the output is observed, the stimulus-response situation. But the thruput in the system can also be manipulated—as in plucking a piano string, stimulating a neurone pool or cutting a nerve tract, or blocking an artery or a highway—and the spread of, or adjustment to, the disturbance tells much about the system. The quantitative relation between magnitude of displacement and strength of restoring influence—linear, concave, convex, sigmoid, or more complex—as also the existence of different or like mechanisms for restoring displacements from opposite directions, and whether the return is oscillating or damped, might serve to group widely different orgs into classes. There is a limit of homeostatic tolerance, an amount of displacement of a system beyond which it will not return. Change is then irreversible, and process leaves behind it structure—behaving shifts to becoming and alters being, sometimes leading to pathology and dissolution.

General questions can also be asked at this level about the degree of displacement tolerated in relation to kind, repetition, frequency, direction, and other aspects of the load; about the safety factor; about the speed of change of physiological zero, or adaptation; and about many other matters. Moreover, since structure is a product of history, or irreversible process, the character of the material change can serve as an index to properties of the action. A highly regular structure, as a honeycomb, indicates a highly determined process, even though this is a behavior of a group of organisms. Striated muscle fibers are highly ordered longitudinally and more variable in section; presumably the micelles are arranged very powerfully, once formed, but the number in a fiber is determined more by chance.

Being; Organization

An organism has organization, an ordering of material in space and of events in time. Any random arrangement is an order; the essence of ordering is that some particular order, out of all possible ones, will be produced. The particular one can be defined in relation to the observer, as near and far; or to some polarity he chooses, as large and small; or to a functionally related object, as key to lock; or to a generatively related object, as parent to offspring; or to an unrelated object, as a photograph or model to the original. Of these, the ability to reproduce itself, along with any fixed aberration, is the most demanding and is especially characteristic of biology; and life has been defined as "the repetitive production of ordered heterogeneity." The guiding information is carried, and the given arrangement is imposed or reproduced by various means, from electric fields around linked pyrimidines in nucleic acids (four of which can "code" the building of the 20 amino acids of proteins), through the protein antigens of cellular immunity, the metabolic and allied gradients of morphogenesis, the engrams of racial or individual experience, to the coded tapes of calculators and the culture traits, especially language, of civilizations.

Communication of information across org boundaries, between entities at the same or different levels, is not only the means of fixing the past; it is also the means of responding to the present. Nerve impulses and hormones, like talk and books, are transient or more enduring signals (or symbols). Perhaps hearing is more important than vision to social man, as is often claimed, because speech is the vehicle for the immediate communication of information in ongoing interacting behavior. Indeed, a major difference between physical, biological, and social orgs may be in the relative importance for them of the energy, substance, information, and meaning that cross their boundaries. The higher the level, the more do individuality and specificity enter and the more is the system coded to, or discriminating of, differential environmental stimuli or information.

The more also does the study of higher level orgs involve the use of experimental methods and mental tools dealing with patterns of relatedness. The forking paths of a nerve impulse through a brain, or an infection in a population, or a rumor in a community reveal connectivity patterns; and for the analysis of these relations of "organized complexity" are coming to hand the new techniques of set, game, and probability theory, of topology and stochastics, and of other nascent branches of mathematics or logic.

History produces structure, and structure determines function—becoming gives being, and this is capable of behaving; order is produced and maintained—but the relations are so intimate and seemingly reciprocal that the distinctions sometimes seem artificial. Further consideration shows that this is not the case. For the function of an org at its level depends on the structure of its subordinate units, and the structure of these subordinate-level orgs depends, in turn, on the history of their sub-subordinate units. Contraction of a muscle fiber is possible by virtue of the fibrillar and membrane structures, and these are produced by processes involving macromolecules, enzymes, and other submicroscopic units. It would lead too far afield to develop the notion, but it deserves thought, that history, structure, and function stand in relation to one another as do cause, org, and purpose. In both triads, time runs, say, from left to right through past, present, and future; and levels rise from left to right through subordinate, ordinate, and superordinate. Incidentally, function (the noun), with an overtone of duty, relates an ordinate unit to a superordinate org; at its own level, functioning has an overtone of pleasure.

Conclusion

In the remaining space, I can merely suggest the concrete application of these considerations. Again a brief recapitulation. The units of man's attention are first concrete objects, directly sensible. These are classified, then seen as populations with variance; dissected or combined, to sub- and superordinate units forming hierarchical levels; compared and analyzed so that functional units replace or add to structural ones; and con-

sidered in relation to time, both as to irreversible development and to maintenance or restoration of equilibrium; and in relation to order and the information carriers that reproduce it. The world of organized experience thus plots on a map, with orgs at different hierarchical levels—molecule, cell (or crystal), organism, group, population (or society)—along the ordinate; and with their properties—becoming, being, behaving—along the abscissa. The entities, the disciplines concerned with them, the manipulative and rational methods for studying them, and the resulting concepts about them, can be classified into appropriate squares of such a table.

The hierarchy has two major branchings: (i) above the molecule level, into more organized entities with or without the collective properties that describe the living; and (ii) above the organism level, into entities based on human or non-human components. Biology is thus superordinate to physics and chemistry and, at its lower levels, coordinate to the earth sciences; it is subordinate to and, at its higher levels, coordinate to the social sciences. The boundaries are reasonably sharp; yet the biochemist or biophysicist or electron microscopist, concerned with molecular traffic and macromolecular edifices, is much closer in attitudes and operations to the physical scientist, while the systematist or population geneticist or ecologist, concerned with organism traffic and population edifices, is much closer to the social scientist, than these different-level biologists are to one another. And perhaps the biologists operating between cell and organism levels are most akin to, say, meteorologists and might find rich mental nutrition by learning how they handle such problems as storms by the study of individual hurricanes, from Alice to Zelda.

The attributes that help define living orgs are (i) highly ordered and clearly bounded heterogeneity, spread over many levels and with many differentiated units at each; (ii) dependable mechanisms for reproducing units and patterns, by reduplication of the information carriers, and for altering them, by recombination of carriers and by the innovating (mutagenic, imprinting) and selective action of environment on the carriers; (iii) powerful homeostatic mechanisms for maintaining and regaining equilibrium, including especially the use of transported material, transmitted activation by energy or signs or signals, and stationary dominance-subordination gradients. The gene, materialized as a macromolecule, and the idea, materialized as an engram, chiefly among the transmitters of enduring order, are the bearers of structural and behavioral heredity; they carry the past of the entity and account for its individuality. The hormone and the nerve impulse and the sound or gesture, chiefly among the transmitters of transient order, are the bearers of information and instruction to and from orgs or their subsystems and evoke adaptive or innovative behavior that maintains the entity or modifies it in conformity with environmental pressures.

The student of the living stands between the students of the material and of the human on an ordinal scale. He deals with entities or orgs or systems that are less when compared to the latter, but more when compared to the former; more various and more individualized: more highly ordered and capable of more varied behaviors; more dependent on a particularized past and a discriminated present and so on fixed or transient information; more devoted to self-maintenance and self-duplication over the short run—by stability, supplied by feedback and inheritance—and more devoted to change and adaptation over the long run—by modifiability, supplied by learning and gene shift and guided by environmental selection; more sensitive to more environmental variables and more able to dissociate the response from the stimulus in magnitude, kind, and time interval; more personified and closer to the observer and harder to dimensionalize and quantify; more "free" to achieve their "purposes" and reach their "values," including survival and "progress," and to be "aware" of the attendant experience of inner "private" and outer public "reality"—if these words add anything to what has been said.

Such an exercise in analysis and integration is more than an exciting mental adventure; it can have important and useful consequences. The attention of an investigator may be directed to other disciplines from which ideas or skills or information can be plucked ready to apply to his own. Social scientists have been slow in exploiting biology in this way, but they could profit much from its approach and content. Acculturation as a stress, culture as a self-regulated internal environment, institutions as organs, ideas as heritable social mutations and subject to the same factors or pressures as operate for organic evolution, ideologies as polar or balanced views of man as a whole entity and man as a unit in a larger unity—such viewpoints can demonstrably aid understanding of the social epiorganism or the body politic.

The interrelations of subdisciplines in an investigator's own field may be exhibited, so that the great unities are not lost in the small particulars. This may spark the seminal insight that leads to a new structuring of the universe of interest and, failing this, must reveal areas of research emptiness or duplication. And this also should favor presentation of biology as a dynamic whole, with a few penetrating concepts replacing a legion of detailed facts and words, to our students and to our public. Life science is a great entity, and part of a greater one; biology, all science, will attract more and better members and more generous and enthusiastic support when, in all senses, the forest is added to the trees.

References and Notes

1. My thoughts on this topic have been much enriched by participation in a symposium on "Concepts of biology" that was sponsored by the Biology Council of the National Research Council about a year ago (the symposium is soon to appear as a monograph) and by the ongoing theory workshop discussions with my colleagues at the Mental Health Research Institute, University of Michigan.
2. R. W. Gerard, "The scope of science," *Sci. Monthly* **64**, 496 (1947); "A biologist's view of society," *Common Cause* **3**, 630 (1950) [reprinted in *Yearbook Soc. Advancement Gen. Systems Theory* **1**, 161 (1956)]; R. W. Gerard and A. E. Emerson, "Extrapolation from the biological to the social," *Science* **101**, 582 (1945); R. W. Gerard, C. Kluckhohn, A. Rapoport, "Biological and cultural evolution," *Behavioral Sci.* **1**, 6 (1956).
3. R. W. Gerard, "Instruments and man," *Instruments* **18**, No. 10 (1945).
4. ———, "The organization of science," *Ann. Rev. Physiol.* **14**, 1 (1952); "From spirits to mechanism: two centuries of biology," in *Facing the Future's Risks*, L. Bryson, Ed. (Harper, New York, 1953), pp. 111–144.
5. Much confusion has arisen from the use of a given word as a noun, a structural connotation, and as a verb, a functional one. Thus, *function* in physiology, *adaptation* in systematics, and *role* in sociology, as examples, when used as nouns, refer to an existing state; as verbs, to an action. The state, in each case, carries an implication of purpose and value, of the org at one level to the superordinate system; and the action, similarly, implies a behavior of the unit that has utility in the larger setting. Adaptation of the individual, in adaptive amplification, is different from the adaptation it has acquired to an environmental situation; the adaptive radiating of a population is different from the adaptive radiations of a phylum.
6. R. W. Gerard, "Levels of organization," *Main Currents in Modern Thought*, **12**, No. 5 (1956).
7. ———, "Organism, society, and science," *Sci. Monthly* **50**, 340, 403, 530 (1940).
8. ———, "Experiments in microevolution," *Science* **129**, 727 (1954).

M. H. Adams, Virologist and Biochemist

Mark Hancock Adams died on 17 October 1956 at the age of 44, at his home in Huntington, Long Island, of a ruptured spleen, a rare complication of a not uncommon and usually mild infectious disease, infectious mononucleosis.

Mark Adams was born on 21 April 1912 in Franklin, Pennsylvania. His mother died a few months later as a result of an infectious complication of her first childbirth. He grew up under the guidance of his father and grandfather, who were both ministers. He attended public school in Rutherford, New Jersey; high school in Baldwin, Long Island; and college in New York City at Columbia University. He took his graduate training in chemistry under J. M. Nelson at Columbia University and received his Ph.D. degree in 1936. Shortly before this event, he was married to a high-school classmate, Hazel Huber. A teacher and nature lover, like Mark, she brought into the marriage a close companionship and complete understanding of him as a person and as a scientist.

At the beginning of his scientific career, he was primarily interested in organic chemistry and enzymology. His first major investigative work, which was the subject of his Ph.D. thesis, was concerned with the enzyme tyrosinase. With characteristic thoroughness, before proceeding with the problem, he critically analyzed the standard methods for enzyme assay and found them lacking in accuracy and reproducibility. He traced the difficulty to an instability of the protein in dilute solutions and found that addition of a protein such as serum albumin protected the enzyme. This was his first work on surface denaturation, a subject which he was to take up again later with the bacterial viruses.

His first five postdoctoral years were spent as fellow and later as assistant at the hospital of the Rockefeller Institute. Again his interests were divided between organic chemistry and biochemistry. In collaboration with W. F. Goebel, he worked on sugar chemistry and then also continued with his work on tyrosinase. He was intrigued by the interaction of this enzyme with its antibody, and his studies were among the first to document thoroughly the finding that an antibody can combine with an enzyme, in fact, precipitate it without interfering with the enzymatic activity. During his stay at the Rockefeller Institute, he participated in a clinical study on the effect of tyrosinase on hypertension, an experience which left him with an attitude of healthy skepticism toward certain types of clinical research, which he transmitted to his students.

In 1942 he joined the staff of the department of microbiology at New York University under the chairmanship of C. M. MacLeod. During World War II he participated in the teaching of medical and dental students in an accelerated program and worked on an OSRD project on gas gangrene. He developed a simple medium for the production of the alpha toxin of *Clostridium welchii* and prepared a toxoid which was used on human volunteers.

After the war he turned to a new field of investigation—bacterial viruses. This branch of microbiology appealed to him because it had just become a quantitative science and, particularly, because it required a broad and thorough knowledge of biochemistry, genetics, physical chemistry, and statistics. It represented the greatest challenge to his inquiring mind. He took a course on bacteriophages which was given in Cold Spring Harbor at the Long Island Biological Laboratories. His unusual gifts were quickly recognized by Max Delbruck, who conducted the course, and at the end of the course it was proposed that he take over the teaching of the course in future years. He accepted, and for 7 years he taught a rapidly expanding course which attracted students of outstanding caliber, among them well-known physicists, biologists and biochemists.

Meanwhile he had started on his own research on bacterial viruses, and, characteristically, his first study led him to investigate certain variabilities in the assay procedure. He rediscovered with the viruses the phenomenon of surface inactivation which he had investigated with tyrosinase. His published paper on this work is a characteristic example of his thorough and critical approach which eliminated a great deal of confusion regarding the concept of "protective colloids." In logical sequence followed several other studies on the stability of bacterial viruses, such as heat inactivation and the effect of metals. In the course of these studies, a marked stimulatory effect of calcium on the *Escherichia coli* phage T_5 production was discovered and was made the subject of a special study. A mutant of T_5 which exhibited increased resistance to heat denaturation was isolated and led to an investigation of simultaneous growth of related phages in a single cell and of exchange of genetic properties. These experiments stimulated Mark Adams to meditation regarding phylogenetic relationships between viruses and the evolution of new viral types. Experiments on hybridization between the *coli* phage T_5 and the *Salmonella* phage PB were then pursued. By now he was deeply involved in problems of the classification of viruses and wrote several papers which contain thorough and critical analyses of criteria for the classification of bacterial viruses.

About 5 years after he had entered this new field, he was considered one of the leaders in the bacteriophage field, and, as an inevitable result, was frequently asked to write review articles and to participate in symposia. Some outstanding contributions were the results of these efforts. One of them, entitled "Methods of study of bacterial viruses," is a classic to which most workers in the field continuously give reference. Another, on the role of polysaccharides in virus reproduction, is a model review with respect to lucidity and critical analysis. A detailed and brilliantly written monograph on bacterial viruses, almost completed at the time of Mark Adams' death, will be published posthumously.

These many writing activities did not prevent Mark Adams from starting a new line of inquiry in his research. He approached the problem of the various stages of virus-host cell interaction. Investigation of the kinetics of absorption at various temperatures, observations on "abortive" infections at low temperatures, frequency distributions of phage release in one-step growth experiments, and finally the description of an enzyme, a polysaccharide depolymerase which is liberated by infected bacteria, are among the latest contributions from the laboratory of Mark Adams.

As a teacher he was outstanding. Students who may have feared him at the beginning of a course were his admirers at the end. William Osler once said that a university has a dual function: to teach and to think. Mark Adams taught and thought and taught others to think. His devotion to teaching was so apparent and his pleasure in helping others so obvious that no one hesitated to seek his

advice, although knowing that the problem would probably be dissected in such a manner that perhaps nothing would be left of it. In his lectures, Mark Adams exhibited an unusual gift for developing a scientific theme and for bringing continuity and clarity to a subject of the most complex structure. Above all, his enthusiasm for the critical analysis of the scientific problem, which he tried in vain to restrain, was transmitted to the audience, and he could carry his listeners along through foreign territories. If there was evidence that was inadequate, or if there was a flaw in the reasoning, or if there was perhaps a little wishful thinking, it would never escape his notice.

It was not surprising that these particular talents should be called upon by an invitation to join the Editorial Board of *Science* in 1953. Among his many editorial contributions, his book reviews were outstanding. They embraced subject matter as far apart as chemistry, enzymology, infectious diseases, and Roman history. They all bear the mark of his incisive thinking and his uncompromising attitude toward loose talk. This uncompromising attitude was the same whether he was confronted by a book or by experimental data of his friends and students or his own. Perhaps sometimes his criticism was ill received by some who did not grasp the spirit in which it was given. Having shared a laboratory with Mark Adams for 8 years, I may perhaps qualify as a key witness in testimony of his critical abilities which spared no time or effort to unveil the precise and relevant facts. That it did not mar the relationship to his friends and students was merely due to the fact that he did not successfully hide from them his gentle kindness, warm affection, and selfless interest in their mental and personal development.

Those who knew Mark Adams only as a quiet and rather shy person, or those who knew him only as a sharp critic, may have been surprised to see him perform as master of ceremonies at a Christmas party or at the yearly farewell party at the end of the phage course. His imagination, powers of observation, and sense of humor came to the surface at these occasions and filled many joyful evenings.

Mark Adams had several avocations. They were pursued with the same thoroughness and perfectionism as his scientific endeavors. Together with his wife, he studied ornithology and archeology, he was interested in photography and enjoyed sailing. During one summer in Woods Hole he became interested in oil painting. He began by watching a friend paint for several days. After absorbing all the essentials of the procedure, he set out on his own. His second effort, a portrait of a fellow-scientist, was so accomplished and so original that even the model appreciated the painting and was anxious to acquire it.

In Mark Adams we have lost one of our most critical and courageous minds. We miss a brilliant teacher who was capable of transmitting the vibrations of his own enthusiasm. An investigator has left us who did not care how far the road he was building would stretch; who was more concerned that the road could be used by others too. And many of us have lost a teacher and friend whose unostentatious gentleness and warmth will remain in our memory, together with the image of a man utterly and uncompromisingly devoted to scientific truth.

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News of Science

Westinghouse Talent Search

High-school science students from 41 states and the District of Columbia have been selected as winners of 260 honorable mention awards in the 16th annual Science Talent Search. The 205 boys and 55 girls were chosen from a total of 3122 graduating seniors who represented schools in all 48 states and Washington, D.C.

Like the 40 winners named earlier who are competing this month for the Westinghouse science scholarships, all of those who receive honorable mention will be recommended to colleges and universities for scholarships. Selection of the 40 winners and 260 honorable mentions was based on the students' scholastic records and teacher recommendations, their science projects, and their standing in a science aptitude examination.

First place among states producing honorable mention winners this year is again New York with 58, 40 boys and 18 girls. California and Illinois rank second with 19, 18 boys and one girl in the former and all boys in the latter. Third place goes to Pennsylvania with 16 winners, 13 boys and three girls. Ohio's 12 winners, ten boys and two girls, give that state fourth place. Massachusetts is fifth with 11 honorable mentions, seven boys and four girls.

All of the honorable mention recipients have excellent scholastic records, and the judges have reported that they rank close behind the 40 winners who will compete for top national honors in Washington, 7–11 Mar., during the annual Science Talent Institute. One hundred four of them—77 boys and 27 girls—rank first, second, or third in their classes.

Fifty-seven of the boys and four of the girls selected for honorable mention have named physics as their first choice for future careers. Fifty boys and one girl hope to find careers as engineers, and 39 in the group favor some branch of chemistry. A total of 34, including 11 girls, prefer medicine. Nine girls hope to be teachers. One boy chose the ministry and one girl the writing profession.

The Science Talent Search is conducted by Science Clubs of America through Science Service. The Westinghouse Educational Foundation, supported by the Westinghouse Electric Corporation, provides the awards and makes the Science Talent Search financially possible.

Army's Solar Furnace

The Department of the Army has announced that a large solar furnace capable of concentrating the sun's rays to produce temperatures comparable to those generated by an atomic explosion will be erected at the Quartermaster Research and Engineering Center, Natick, Mass. The furnace will have an energy equivalent of approximately 28 kilowatts.

The facility will be utilized for laboratory testing of materials intended for the protection of military personnel against the thermal effects of nuclear and other weapons. Standard sources of intense heat, such as high-current electric arcs,

gas-fired panels, burning magnesium, and incandescent lamps, are not adequate because they are not hot enough, do not uniformly cover a sufficiently wide area, and are not easily controlled. While reliance will be placed on atomic field trials for final testing of materials against thermal effects, the solar furnace is expected to reduce the time and cost of developing heat-resisting materials.

The installation consists of four principal elements: heliostat, concentrating mirror array, attenuator, and test chamber, which will occupy an area that will be about 125 feet in length by 40 feet in width. At one end of the assembly is the heliostat, a flat mirror 40 by 36 feet, which receives the sun's rays and reflects them a distance of 96 feet upon the concentrating mirror array at the other end of the assembly. An automatic positioning system drives the heliostat and keeps it constantly at the correct angle with the sun. Thus, the directly reflected rays will always illuminate the concentrator, regardless of the time of the day, month, or year.

The concentrating array consists of 180 curved surface mirrors, each 23.5 inches in diameter, which reflect the rays back in the direction of the heliostat, but concentrate them within the target or test chamber, which stands between the heliostat and the concentrating mirror array. Before reaching the target chamber, the concentrated rays pass through the attenuator, a venetion-blind type of shutter which can reduce the intensity of the light when desired.

Finally the sun's rays are focused within the test chamber in a 4-inch diameter beam, representing the concentrated energy reflected from the surface of the heliostat and the concentrating mirror. It is within this concentrated beam that the articles that are to be tested will be exposed. The measuring apparatus, shutters, controls, and laboratory facilities are housed in the test chamber, which is reached by a small elevator platform. Ground for construction of the solar furnace was recently broken and it is expected that the installation will be completed and ready for operation by summer of this year.

Geology for College Teachers

The department of geology at the University of Illinois has announced the first summer institute in geology for college geology teachers to be held at Urbana, from 17 June to 10 Aug. The institute, which will be on "Geologic frontiers: recent concepts and methods in mineralogy and geochemistry, and their application to geology," is supported by the National Science Foundation.

The institute will be conducted by D. M. Henderson and A. F. Hagner of the University of Illinois, and R. M. Garrels of Harvard University, with the assistance of approximately 15 distinguished scientists from throughout the nation. For information and application blanks write to one of the codirectors, D. M. Henderson or A. F. Hagner, Department of Geology, University of Illinois, Urbana, Ill. Applications should be filed *by 1 Apr.*

U.K. Institute for Nuclear Science

The British Government is to set up a national institute for research in nuclear science. Enoch Powell, Financial Secretary to the Treasury, has reported to the House of Commons that the main object of the institute would be the provision of facilities and equipment for research in the nuclear field. He emphasized that the institute would not take over the research now being done in universities with assistance from government funds. Nor will it affect British participation in the international project for common facilities in Geneva. In the government's view, Powell stated, the institute will fill a gap that would otherwise exist in British ability to keep in the forefront of nuclear progress.

Excerpta Medica and Soviet Medicine

As a result of plans initiated by the Public Health Service, National Institutes of Health, U.S. Department of Health, Education, and Welfare, arrangements have recently been completed with the Excerpta Medica Foundation, New York, under which for the first time an extensive review of the Soviet medical literature in all areas of medicine will now be available in the United States. The plan calls for the translation and publication of abstracts of the Soviet medical literature, including reports of work now being done in various cities throughout the U.S.S.R.

The abstracts will be prepared by Soviet specialists, the material being edited and supervised by a permanent editorial committee of 30 Soviet scientists appointed by the Excerpta Medica Foundation in cooperation with the Presidium of the Academy of Medical Sciences of the U.S.S.R. These abstracts will be supplemented by verbatim translations of abstracts of the Soviet literature in specially selected fields. The abstracts will be published under the title *Abstracts of Soviet Medicine* and will appear throughout 1957 as two separate publications: part A, *Basic Medical Sciences,* and part B, *Clinical Medicine,* totaling together some 1300–1400 pages.

U.S. Marriages

Marriages in the United States increased last year, reaching an estimated total of about 1,587,000, compared with 1,542,000 in 1955 and 1,491,000 in 1954, according to Metropolitan Life Insurance Company's statisticians. The rate of marriages was 9.4 per 1000 population (including the Armed Forces overseas), compared with the postwar low of 9.2 per 1000 in 1954.

Most states recorded small increases in marriages, but in two states, Indiana and Oklahoma, there was a pronounced upswing—almost 17 percent in Indiana, and about 11 percent in Oklahoma. The statisticians predict that the annual increase is likely to be small for the balance of this decade, but that after the early 1960's the number of marriages should rise rapidly as the large number of persons born after World War II come of age.

Applications from High Schools Solicited for Traveling Library

The Traveling High School Science Library Program, supported by a grant from the National Science Foundation and administered by the AAAS, is now making plans for the academic year 1957–58. A description of the 1956–57 program and a list of the 200 books in the traveling libraries presently serving 104 senior high schools have been published [*Science* **124,** 1013 (23 Nov. 1956); *Sci. Monthly* **83,** 300 (Dec. 1956)].

During 1957–58 it is hoped that the program will be extended to approximately 300 senior high schools which will receive 50 books at a time in traveling cases. Each school will exchange books with other program schools at intervals of 2 months, so that every school will have had an opportunity to use all 200 books in the traveling library during the year.

The program is intended to increase the interest of high-school students in science, to encourage the choice of careers in science, and to broaden the science and mathematics background of high-school teachers. The program also serves to stimulate the acquisition of well-chosen science books for school and public libraries.

The greatest apparent need for this program is in small and medium-sized high schools in nonmetropolitan localities that lack good community library facilities. The following general criteria will guide the selection of about 300 program schools for next year: (i) the school should have an enrollment of at least 150 but not more than 750 students in the 10th to 12th grades, inclusive; (ii)

good community library services should not be readily accessible to the students at the school; (iii) the school should have a library and employ a school librarian.

The principals of public and private high schools or preparatory schools interested in receiving additional information and application blanks are requested to write immediately to Dr. Hilary J. Deason, American Association for the Advancement of Science, 1515 Massachusetts Ave., NW, Washington 5, D.C. The final date for the receipt of formal applications for the 1957–58 program is *15 May*. Priority of receipt of application will be a factor in school selection.

Thai Dam Dedicated

Thailand's large new irrigation and navigation dam near Chainat, some 100 miles north of Bangkok, was officially dedicated by King Phumiphon and Premier Pibulsonggram on 7 Feb. An $18-million loan from the International Bank for Reconstruction and Development, a United Nations special agency, helped toward the total cost of $58 million, and the U.N. Economic Commission for Asia and the Far East provided technical aid. The Chainat dam will insure a controlled water supply for a rice-growing area the size of Northern Ireland, introduce double-cropping, add some 500,000 tons a year to Thailand's rice exports, and make possible year-round navigation on the central course of the Chao Phya River.

Blakeslee Awards

Entries for the American Heart Association's Howard W. Blakeslee awards for outstanding reporting in the field of heart and blood vessel diseases must be submitted *by 1 May*. The Awards Committee will make its selections from among newspaper and magazine articles, books, radio and television programs, and films published or produced between 1 Mar. 1956 and 28 Feb. 1957.

This is the fifth in a series of Blakeslee awards, each of which carries an honorarium of $500. The number of winners to be selected this year will be determined by the judges. Presentation will be made at a meeting of the American Heart Association to be held in the fall. Entry blanks and rules folders may be obtained from the Association, 44 E. 23 St., New York 10, N.Y.

The Blakeslee awards honor "individuals whose creative efforts in any medium of mass communication are judged to have contributed most to public understanding of progress in research, and in the prevention, care and treatment of heart and circulatory disease." The rules further state that "entries will be judged on the ability of the entrant to project a positive and hopeful viewpoint toward problems of the heart and circulation."

Borazon

The General Electric Company recently announced a new synthetic substance that compares with the diamond in hardness. The substance, borazon, is a boron-nitrogen compound that is more resistant to heat than the diamond is, being able to withstand temperatures of more than 3500°F. The diamond burns up at 1600°F. Borazon was produced by applying pressures of 1 million pounds per square inch and temperatures of 3000°F. Under these conditions the boron-nitrogen compound changes its crystalline form to that of a cube and is therefore called cubic boron nitride. Robert H. Wentworth of the General Electric Research Laboratory in Schenectady, N.Y., discovered Borazon.

TV in Schools

Alexander J. Stoddard, former superintendent of schools in Philadelphia and Los Angeles, urged that all American public schools be equipped with closed-circuit television in order to raise the quality of instruction, overcome the critical shortage of teachers, and provide the necessary funds for substantial increases in teacher salaries, in a report, *Schools for Tomorrow*, published by the Fund for the Advancement of Education. If this were done and an appropriate educational program instituted it would, according to Stoddard, result in a saving of 100,000 teaching positions and more than $500 million in teaching salaries. Stoddard said that no elementary, junior, or senior high school should be built without one or more television studios and closed-circuit apparatus to all parts of the building.

Additional copies of *Schools for Tomorrow* may be obtained without charge from the offices of the Fund, 655 Madison Avenue, New York 21, N.Y.

Ferromagnetic Substances

Ever since the beginning of the century, when Heusler discovered that alloys of copper and manganese, with an addition of aluminum, become ferromagnetics (the Heusler alloys), the preparation of artificially ferromagnetic substances has been of interest both experimentally and theoretically. Recently Raub *et al.* have investigated the magnetic properties of gold-manganese alloys (*Z. Metallkunde* **57**, 9, 1956; *Umschau* **56**, 538, 1956).

Pure gold is diamagnetic—its magnetization at small fields is opposite to the direction of the field. Metallic manganese is paramagnetic (almost temperature independent) and has a lattice constant of 2.58 A, but MnAs and MnSb, with lattice constants 2.85 and 2.89, are ferromagnetic. It seems, therefore, that manganese leads to ferromagnetic material when the distance between the manganese atoms is increased; this also appears to be the case with some of the manganese-gold alloys. It is possible to detect in the gold-manganese system an alloy that is 15 to 23 percent manganese, or approximately the composition of Au_4Mn, which is ferromagnetic.

There exists another phase, AuMn. This is antiferromagnetic; the neighboring domains are magnetized in opposite directions (as one can show directly by neutron diffraction). However, there is still another phase, Au_2Mn, and this seems to indicate that the system consists of a super position of ferromagnetic and antiferromagnetic domains. In the other phases of the manganese-gold system there are mixed crystals with a temperature-dependent paramagnetism and a temperature-independent paramagnetism in the crystals of the type $AuMn_3$.

It is therefore possible in one and the same material, depending on the composition, to produce almost all the various types of magnetism that are known. —K. L.-H.

Edison Children's Book Award

The Thomas Alva Edison Foundation presented its children's book awards for 1956 last month at the National Edison Birthday Celebration dinner, held by the Edison Foundation at the Waldorf-Astoria in New York in honor of the 110th anniversary of Thomas Alva Edison's birth. The occasion marked the inauguration of National Science Youth Day on 11 Feb., henceforth to be an annual event commemorating Edison's birth for the purpose of stimulating a greater interest in science and scientific careers.

The children's book awards are part of the Edison Foundation National Mass Media Awards Program, established in cooperation with 62 national organizations, to encourage mass media productions that (i) interest boys and girls in science, in view of the serious shortage of scientific manpower; (ii) make meaningful the values of the American tradition; and (iii) present ideals and heroes worthy of emulation by children. The $250 award for the best children's science book (for younger children) went to Roy A. Gallant, author, and Lowell

Hess, illustrator, of *Exploring the Universe*, which was published by Garden City Books, a division of Doubleday and Company, Inc.

Los Alamos Opened

The Atomic Energy Commission permitted controls governing public access to Los Alamos, N.M., to be removed on 18 Feb. Since 1943, when the atomic installation was set up, admission to Los Alamos has been by pass only. Furthermore, visitors have had to get permission to enter the town at least 24 hours in advance.

The new AEC decision applies only to restrictions on movement into and out of the community. There will be no relaxation of controls over access to the Los Alamos natural science laboratory itself. The government will continue to own all real estate and existing facilities within the technical area and the present community areas.

The commission has reported that its decision to open the city was based on several points, among them the saving of nearly $100,000 a year on gate-control costs, the making possible of private financing of home sites in nearby areas, the private leasing of government-owned land and buildings for commercial purposes, and the aiding in recruitment of employees.

Biology at Randolph Macon

An anonymous gift of $350,000 has been made to Randolph-Macon Woman's College to strengthen its biology and mathematics programs. At the donor's suggestion, $35,000 will be applied to general administration and $50,000 to strengthen the mathematics program. The rest will go to the special program in biology.

The gift will provide scholarships yearly to applicants who show the greatest promise in biology and in mathematics. Other scholarships will be provided as well as assistantships, graduate fellowships, research support for faculty members, and new equipment.

Cardiovascular Training Program

A new 1-year term of the special postgraduate cardiovascular research and training program at the Medical College in Augusta will start on 1 July. It will enable about five postdoctoral students to receive intensive training in cardiovascular research under the direct supervision of William F. Hamilton, president of the American Physiological Society and professor of physiology, and Raymond P. Ahlquist, professor of pharmacology. The course is sponsored by the American Heart Association and the National Heart Institute of the U.S. Public Health Service.

A stipend of $3400, plus $350 for each dependent, will be provided. Inquiries and requests for application forms should be addressed to either Hamilton or Ahlquist, who are codirectors of the program.

Astro-Geophysics at Colorado

Fundamental research in solar-terrestrial relations will be stressed in a new graduate department of astro-geophysics recently established at the University of Colorado. Doctoral candidates in the department will be able to take advantage of the research and laboratory facilities of the High Altitude Observatory, the Central Radio Propagation Laboratory of the National Bureau of Standards, and the university's department of physics.

RCA Teaching Scholarships

Responding to the need expressed by educators for more qualified teachers of science and mathematics, the Radio Corporation of America has established 30 college and university scholarships for students who are preparing for the science teaching profession. These scholarships, which will be awarded at 20 different teacher-training colleges throughout the country, are actually an extension of the long-established RCA scholarship and fellowship program.

N.Y.U. Mathematical Sciences Institute

The Institute of Mathematical Sciences at New York University offers temporary memberships to mathematicians and other scientists holding the Ph.D. degree who intend to study and do research in the fields in which the Institute is active. These fields include functional analysis, ordinary and partial differential equations, mathematical physics, fluid dynamics, electromagnetic theory, numerical analysis and digital computing, and various specialized branches, such as hydromagnetics and reactor theory.

The temporary membership program is designed primarily as a means of alleviating the present critical shortage of scientists trained in mathematical physics, applied mathematics, and related fields of mathematical analysis. The program is being supported by the National Science Foundation and also by funds contributed by industrial firms.

Temporary members may participate freely in the research projects, the advanced graduate courses, and the research seminars of the institute, and they will have the opportunity of using the computational facilities.

The temporary members will receive a stipend commensurate with their status.

Membership will be awarded for a year, but it may be renewed. Special arrangements can be made for applicants who expect to be on leave of absence from their institutions. Requests for information and for application blanks should be addressed to the Membership Committee, Institute of Mathematical Sciences, 25 Waverly Place, New York 3, N.Y.

Geophysical Observatory in France

The French National Center for Scientific Research is spending more than 600 million francs, plus equipment costs, to build the new National Geophysical Observatory near Pouilly-sur-Loire in France. Seven laboratories and numerous other buildings will house special equipment for scientific studies to be made there. Houses are being built for the 70 scientists and technicians who will form the permanent staff of the new observatory.

Beckman and Statham

Beckman Instruments, Inc., which has headquarters in Fullerton, Calif., and Statham Laboratories, Inc., Los Angeles, Calif., have jointly announced that agreement has been reached to merge the two firms, subject to the completion of legal details and the approval of shareholders. Statham, with production facilities in Los Angeles and Puerto Rico, manufactures precision pressure transducers, accelerometers, and other devices used in aircraft and guided missiles and for scientific and industrial measurement and control. Beckman manufactures precision components, measuring and control instruments, computers, and data-handling systems.

Scientists in the News

JAMES B. CONANT, organic chemist and emeritus president of Harvard University, has resigned as United States Ambassador to the Federal Republic of Germany to return to private life.

ARNIE J. SUOMELA of Oregon has been nominated by President Eisenhower to be the first commissioner of fish and wildlife. The office, a new one in the Department of Interior, was created by

Congress last year. Suomela now is serving as assistant director of the Division of Wild Life Services. He headed the Oregon Fishery Department from 1945 to 1953.

Col. JOE M. BLUMBERG, Medical Corps, U.S. Army, has been appointed Army deputy director of the Armed Forces Institute of Pathology, Washington, D.C. He succeeds Col. FRANCIS E. COUNCIL, MC, USA, who will retire from the Army on 31 Mar.

ORR E. REYNOLDS, director of the Biological Sciences Division of the Office of Naval Research since 1949, was appointed on 1 Mar. to a position as director of the Office of Sciences, which is under the Assistant Secretary for Research and Development in the Office of the Secretary of Defense. Reynolds has been with ONR since its organization 10 years ago, when he was named head of the physiology branch.

BENO GUTENBERG, director of the Seismological Laboratory of the California Institute of Technology, has been awarded the Emil Wiechert medal of the German Geophysical Association in appreciation of his accomplishments in seismology and in the investigation of the earth's structure. This is the second award of the medal, founded in 1955, for outstanding accomplishment in geophysics.

The Phi Delta Epsilon Fraternity has presented its annual award of merit to JOSEPH KAPLAN, professor of physics at the University of California, Los Angeles, who is at present serving as coordinator of the American contributions to the International Geophysical Year.

FRED W. JENSEN, head of the chemistry department at the Agricultural and Mechanical College of Texas, will resign that post to devote full time to his duties as distinguished professor of chemistry at Texas A. and M. next fall.

FRANK F. KATES, formerly of the Hughes Aircraft Company, has been named director of research and development at Advance Industries, Inc., Cambridge, Mass. Kates is a specialist in guided missiles, fire controls, analogue computers, and infrared detection.

WALTER G. VINCENTI, for the past 16 years a research scientist at the Ames Aeronautical Laboratory at Moffett Field, Calif., has been appointed a professor on the Stanford University engineering faculty. Vincenti is known for his theoretical and wind-tunnel research on the properties of airplane wings at transonic and supersonic speeds.

HENRY HURWITZ, JR., nuclear physicist who joined the Knolls Atomic Power Laboratory staff in 1946, has been appointed manager of the nucleonics and radiation section at the General Electric Research Laboratory, Schenectady, N.Y. Hurwitz was a member of the research group that worked at Los Alamos on the early phases of the development of the hydrogen bomb.

AMOZ I. CHERNOFF has been appointed associate professor of medicine in the Duke University School of Medicine. From 1952 to 1956 he served on the faculty of the Washington University School of Medicine (St. Louis).

CHARLES H. OTIS, for the past 26 years a member of the staff of the department of biology, Bowling Green State University (Ohio), has retired from active teaching with the title professor emeritus of biology. Otis relinquished the chairmanship of the department in 1947 in order to devote his entire time to teaching; he was succeeded by WALDO STEIDTMANN. At the latter's untimely death in the summer of 1955, Otis became acting chairman of the department. He has since been succeeded in that post by JACOB VERDUIN, formerly of Ohio State University.

Otis plans to continue his research on the day lily (*Hemerocallis*), experimental work with which he has been engaged for some 10 years. This work is conducted in part at Bowling Green, but chiefly in his own test garden in Ann Arbor, Mich.

LLOYD A. COOK, former vice president for instruction and research at Wayne State University, has been appointed vice president for graduate studies and dean of the Wayne graduate school.

LUCIEN M. BIBERMAN has been appointed by the University of Chicago to the position of director of the electronics division of the Chicago Midway Laboratories. Since 1944 Biberman has been a member of the technical staff of the Naval Ordnance Test Station, China Lake, Calif., where he was responsible for the design of the NOTS Aeroballistics Laboratory and for the early sidewinder seeker design. His most recent work has included studies of missile vulnerabilities and countermeasures. In his new post, Biberman will be concerned with infrared, optical, and electronics projects.

MILISLAV DEMEREC, director of the department of genetics of the Carnegie Institution of Washington at Cold Spring Harbor, N.Y., and of the Long Island Biological Laboratory, has received an honorary degree from Hofstra College.

FREDERICK W. BROWN, director of the Boulder Laboratories of the National Bureau of Standards, has been appointed by the chief of the telecommunications division of the U.S. Department of State to head up the 71-member committee on technical questions of the International Radio Conference which is scheduled to meet in Geneva, Switzerland, the latter part of 1959. RALPH SLUTZ, chief of the Boulder Laboratories radio propagation physics division, has been appointed vice-chairman of the committee.

The conference is held whenever cooperating countries feel that it would be wise to review the use of the radio spectrum and agree upon the best utilization in order to prevent interference and confusion between radio services. The last meeting was held 10 years ago in Atlantic City, N.J.

MARK W. ZEMANSKY, head of the physics department at the College of the City of New York, has received the Oersted medal of the American Association of Physics Teachers. The medal is given for "notable contributions to the teaching of physics."

GUSTAVE SHAPIRO has been named chief of the engineering electronics section of the Electricity and Electronics Division at the National Bureau of Standards. Shapiro, who has been serving as acting chief of the section, will continue to direct the section's program of research and development in general electronic miniaturization techniques, expendable assemblies, circuit standardization, resistor noise, metal-insulator laminate characteristics, transistor reliability, and aging studies.

Another NBS appointment is that of ROBERT S. MARVIN as chief of the newly formed rheology section. The objectives of the new section will be to maintain and develop rheological standards as well as to develop new types of rheological measurements, particularly those applicable to investigations of the nonlinear relations between stress, strain, and time in fields that are not now being emphasized in other NBS sections. At present the only material standards of this sort issued by the bureau are the standard viscosity oils, but it may well be that as the understanding of rheological properties grows and methods of measurement develop in this field, other types of standards will be required. Marvin first came to the bureau in 1949 to set up and develop a program for the measurement of dynamic properties of polymers.

CARL-GUSTAF ARVID ROSSBY, internationally recognized meteorologist and past president of the American Meteorological Society, and VINCENT JOSEPH SCHAEFER, director of research for the Munitalp Foundation, were honored at the Meteorological Society's recent annual meeting. Rossby, who is director of the Institute of Meteorology in Stockholm, Sweden, received the award for outstanding services to the society "for his great vision and tireless efforts in transforming the American Meteorological Society into an international scientific and professional organization."

Schaefer received the award for outstanding contributions to the advance of applied meteorology "for original contributions in the field of experimental and physical meteorology, particularly his pioneering work in artificial nucleation." This industrial weather award, which includes a stipend of $500, was established by Weather Corporation of America.

ROBERT H. PARKER, a biologist on the staff of the University of California's Scripps Institution of Oceanography, is to receive the presidential award of the American Association of Petroleum Geologists for the most significant contribution to geologic research in 1956 by a person less than 35 years old. Parker has studied the numbers and kinds of invertebrate animals found in recent sediments on the sea floor off the Mississippi Delta. He has found that certain groupings of these are characteristic of specific environments. These observations help geologists who are studying sediments to determine whether or not a particular stratum represents an old bay, a sandy beach, or other environment.

Parker's findings were summarized in "Macro-invertebrate assemblages as indicators of sedimentary environments in the East Mississippi Delta region" [*Bull. Am. Assoc. Petroleum Geol.* **40** (Feb. 1956)]. The award, a gold medal and a small cash prize, will be presented at the annual meeting of the association in St. Louis in April.

EUGENE GREULING, associate professor of physics at Duke University and a specialist in the theory of radioactive beta decay, has joined the John Jay Hopkins Laboratory for Pure and Applied Science of General Dynamics Corporation's General Atomic Division, San Diego, Calif., for a 6-month period. During his stay, Greuling will engage in research on beta decay with Luthar W. Nordheim, a senior member of the laboratory staff who formerly was professor of physics at Duke.

PAUL S. BARKER, a member of the University of Michigan Medical School faculty since 1925, was appointed acting chairman of the department of internal medicine on 1 Feb. He replaces CYRUS C. STURGIS, who has asked to be relieved of the administrative duties of chairman so that he may concentrate on his teaching and private practice. Sturgis has been chairman of the department since 1928.

Another Michigan appointment is that of GOODWIN R. GREENBERG, who was named professor of biological chemistry on 16 Feb. He had been an associate professor at Western Reserve University in Cleveland, where he conducted research on the synthesis of the purines.

HANS POPPER has been appointed full-time director of the department of pathology at the Mount Sinai Hospital, New York, and professor of pathology, College of Physicians and Surgeons, Columbia University. He was for many years director of the department of pathology, Cook County Hospital; scientific director of the Hektoen Institute for Medical Research; and also professor of pathology, Northwestern University Medical School—all in Chicago. Popper succeeds PAUL KLEMPERER.

RICHARD F. FLINT, professor of geology at Yale University, has received a Wenner-Gren Foundation travel grant to visit Africa next summer to examine sites where evidence of ancient man has been found. He will visit key localities in the Belgian Congo, Uganda, Kenya, Tanganyika, Rhodesia, and the Union of South Africa. At each he will join in a field examination with scientists who have made significant discoveries there and will attempt to learn what further research could be accomplished in order to fit the discoveries into a geologic sequence of events.

The carbon-14 method, as used in the Yale Geochronometric Laboratory, has a reach of only about 30,000 years and, therefore, can be applied only to the records of later human cultures. The earliest human records, which may be more than 10 times as old, are too ancient for age measurement as yet. But it is hoped that their positions can be fixed by their relationships to world-wide events such as changes of climate.

LARS G. SILLEN, dean of the chemistry department at the Royal Institute of Technology in Stockholm, Sweden, has been named Arthur D. Little visiting professor of chemistry at Massachusetts Institute of Technology for the current semester. During his stay he is delivering a series of 20 lectures on "Studies on chemical equilibria."

ZENAS R. BLISS, executive officer of the engineering department at Brown University, has been named dean of the university. Bliss has been a member of the engineering division since he joined the faculty in 1923.

W. ALBERT NOYES, JR., dean of the graduate school of the University of Rochester, editor of the *Journal of the American Chemical Society*, and a specialist in the chemical effects of light, has won the 1957 Willard Gibbs medal in chemistry. His selection was announced recently at a meeting of the ACS Chicago Section, which sponsors the award. One of the highest honors in American chemistry, the Gibbs medal goes to Noyes for his contributions to science in the United States and abroad as a researcher, teacher, government adviser, and editor.

WALTER F. ROGERS, chief chemist, Houston Production Division Chemical Laboratory, Gulf Oil Corporation, Houston, Tex., will receive the 1957 National Association of Corrosion Engineers' Frank Newman Speller award for achievements in corrosion engineering. The association's Willis Rodney Whitney award will go to CARL WAGNER, professor of metallurgy at Massachusetts Institute of Technology. The awards will be presented on 13 Mar. at the Sheraton-Jefferson Hotel, St. Louis, Mo., during the NACE's 13th annual conference and exhibition.

Recent Deaths

JOSEPH G. HAMILTON, Berkeley, Calif.; 49; director of Crocker Radiation Laboratory at the University of California, Berkeley; 18 Feb.

EMILIO P. MEINECKE, San Francisco, Calif.; 87; retired forest pathologist for the U.S. Department of Agriculture; 11 Feb.

HARRY A. PATTISON, Claverack, N.Y.; 79; leader in the rehabilitation of tuberculosis patients; 14 Feb.

STUART H. PERRY, Tucson, Ariz.; 82; retired newspaper publisher who became interested in meteorites and wrote *The Mallography of Meteoric Iron*; 14 Feb.

HENRY N. RUSSELL, Princeton, N.J.; 79; professor emeritus of astronomy at Princeton University; vice president of AAAS–Section A in 1917 and president of AAAS in 1933; 19 Feb.

CARVETH WELLS, Southampton, Bermuda, and New York, N.Y.; 70; former assistant professor of engineering at London University; author, lecturer, and explorer who led many museum expeditions; 16 Feb.

Reports

Effect of Genes on Birefringence End-Point Temperature of Starch Grains in Maize

As measured by loss of birefringence, the gelatinization temperature of starch grains of normal dent corn in water ranges between 62° and 73° C (*1*). Recent work in our laboratories on birefringence end-point temperatures of starch granules produced under the control of certain genetic factors has shown a remarkable range. Differential modification of such end-point temperatures by certain salt solutions is also reported here.

Eight cultures of maize, each homozygous for a different endosperm genotype, were used. One had the normal dent genotype, each of four carried one of the recessive genes *du, ha, su*$_2$, and *wx*, while the remaining three carried the doubly recessive combinations *du, ha, du su*$_2$, and *ha su*$_2$. Descriptions of these genes have been given previously (*2*).

Starch was isolated from mature caryopses of a single self-pollinated ear of each culture, and a portion of the starch sample was analyzed for amylose content following the method of Dunn *et al.* (*3*). The determination of gelatinization temperature on the remaining part of the sample was accomplished by means of a specifically designed aluminum stage in which starch granules mounted in liquid sealed between microscope-slide cover slips with stopcock grease could be observed in both polarized and normal light. The stage was heated by electric coils imbedded in the base, and the heating rate was controlled at approximately 3°C per minute by a variable transformer. The temperature of the stage was determined by a thermometer that was inserted into the stage in close proximity to the starch-granule chamber.

The birefringence end-point temperature was considered to have been reached when all grains in the observed field lost birefringence. A few atypical starch grains occasionally could be observed which maintained their birefringence beyond the endpoint, but these were not included in the readings. The endpoint was chosen because it appeared to be the most constant feature of the sample and because the values were reproducible within narrow limits by different observers. In addition to distilled water, different concentrations of various salt solutions were used as a suspension medium for the starch grains. Duplicate determinations were made for each genotype-solution combination.

The results of these end-point temperature determinations are presented in Table 1. The *F* test from the statistical analysis indicates highly significant differences among solution means, among genotype means, and for the interaction of solutions times genotypes. Minimum differences necessary for significance at the 1-percent level as calculated by the Scheffé procedure are indicated in the footnote to the table.

From these data, four distinct classes differentiated on the basis of end-point temperature in distilled water can be distinguished. The *su*$_2$ and *du su*$_2$ genotypes were lowest (about 55°C). A second major class contained the normal genotype and those of *wx, du* and *du ha* which reached an endpoint at approximately 70°C. The *ha* genotype gave the highest reading at 89.5°C, with *ha su*$_2$ comprising a fourth distinct class at 83.5°C.

Comparisons of the doubly recessive genotypes with those of the singly recessive types are particularly interesting. Relative to normal starch, it appears that *su*$_2$ alone or in combination with *du* reduces the end-point temperature even though amylose content is increased. The gene *ha*, on the other hand, effects a large increase both in temperature and in percentage of amylose. The *wx* and *du ha* genotypes have starch end-point temperatures similar to that of normal dent corn, but *wx* starch has no amylose while *du ha* starch has a high percentage. Thus, while certain genetic factors may bring about simultaneous changes in end-point temperature and in amylose content, the two properties may not be directly interrelated.

When starch granules are suspended in different salt solutions, further differential effects on end-point temperatures may be noted. Both concentrations of the $Ca(NO_3)_2$ solution considerably depressed the temperature of the *ha* and *ha su*$_2$ genotypes, but this depressing effect was slight or absent in the others. Gelatinization was impeded in both concentrations of the $MgSO_4$ solution, which resulted in a relatively uniform increase in all genotypes. These results suggest that the use of appropriate salt solutions may permit further differentiation of genotypes.

In conjunction with this study, an extensive characterization of the nature of the carbohydrates produced by genes controlling endosperm characters is being

Table 1. Amylose percentage and birefringence end-point temperatures of endosperm starch of eight maize genotypes in various solutions. Mean of duplicate determinations.

Genotype	Amylose (%)	End-point temperature* (°C)					Mean
		Distilled H_2O	$Ca(NO_3)_2$		$Mg(SO_4)$		
			1.0*M*	1.75*M*	1.0*M*	1.75*M*	
Normal	25	69.5	74.0	71.5	83.0	88.5	77.3
wx	0	68.5	71.5	70.0	81.5	88.0	75.9
du	41	69.0	72.5	70.5	81.0	89.5	76.5
ha	69	89.5	84.5	75.0	100+	100+	89.8+
su$_2$	35	55.5	59.0	51.5	68.5	75.5	62.0
du ha	59	70.0	68.0	66.5	83.0	89.5	75.4
du su$_2$	50	56.5	59.0	54.5	68.5	76.5	63.0
ha su$_2$		83.5	77.0	70.5	94.5	100+	85.1+
Mean		70.2	70.7	66.2	82.5+	88.4+	

* Minimum differences (Scheffé procedure) necessary for significance at 1% level: (i) between solution means, 1.0; (ii) between genotype means, 1.4; and (iii) between any two values in table, 3.9.

All technical papers and comments on them are published in this section. Manuscripts should be typed double-spaced and be submitted in duplicate. In length, they should be limited to the equivalent of 1200 words; this includes the space occupied by illustrative or tabular material, references and notes, and the author(s)' name(s) and affiliation(s). Illustrative material should be limited to one table *or* one figure. All explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively, keyed into the text proper, and placed at the end of the article under the heading "References and Notes." For fuller details see "Suggestions to Contributors" in *Science* 125, 16 (4 Jan. 1957).

conducted in the hope that such an approach will provide further information on the specific nature of the reaction controlled by each of the genes (*4*).

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Spectrophotofluorometric Studies of 5-Hydroxyindoles and Related Compounds

The 5-hydroxyindole compounds that are of current interest in psychopharmacology (*1*) and in carcinoid tumor diagnosis (*2*) can be detected best by methods utilizing scanning spectrophotofluorometric procedures (*3*). Problems in the quantification of such procedures are caused by a variety of factors that are known to affect fluorescence—namely, (i) wavelength of excitation (absorbed light); (ii) concentration of the fluorescent substance in solution; (iii) nature of the solvent; (iv) *p*H; (v) temperature; (vi) foreign substances (quenching effects); and (vii) instrumental structure (*4*). In view of this variety, it is of interest to present spectrophotofluorometric data on 5-hydroxyindoles and related compounds in simple systems that are devoid of complicating variables. Such data are useful in the development of quantitative assays for these compounds (*5*).

The compounds investigated in this study and their sources are listed in Table 1. All compounds except those noted were dissolved in distilled water by prolonged vigorous shaking without heat. Difficulties with solubility were generally not encountered with the concentrations used. Spectrophotofluorometric measurements were made on the Aminco-Bowman scanning spectrophotofluorometer calibrated and adjusted to an activation reading of 350 mμ and a fluorescence reading of 450 mμ for quinine at a concentration of 0.1 μg/ml dissolved in 0.1*N* H_2SO_4 (*6*).

Data for any given compound in Table 1 were obtained as follows. (i) Activation and fluorescence maxima were determined by the method described in the instruction manual for the Aminco-Bowman scanning spectrophotofluorometer (*7*). (ii) The widest range of concentrations optimal for measurement wherein these maxima were constant was found. This was an essential preliminary to the development of a standard calibration curve for the compound under test. (iii) Using the now established activation and fluorescence maxima for instrument settings, we determined the range of concentrations (within the afore-mentioned range) that gave a linear response curve as measured by fluorescence intensity. In this way, a standard calibration curve for each of the compounds listed in Table 1 was plotted, and its region of linearity was thereby revealed. This is essentially the procedure that was used in the calibration of the Aminco-Bowman scanning spectrophotofluorometer by quinine (*6*).

The data obtained are set forth in Table 1. Only the maximum activation and fluorescence peaks are presented. These agree well with the values of Bowman *et al.* (*3*). Scanned activation and fluorescence spectra for any given compound also showed subordinate peaks, some of which were not clearly defined. Among these were scatter and harmonic peaks that are not important for purposes of identification. However, activation spectra of the 5-hydroxyindoles and their parent analogs generally showed a definite subordinate peak at 220 ± 5 mμ, and corresponding fluorescent spectra showed a definite subordinate peak at 670 ± 5 mμ. Although minor decreases in *p*H occurred with increasing concentration, especially of acidic compounds, these variations did not affect activation and fluorescence maxima under the conditions of the test. This confirms the findings of others (*3*).

Calculations from data in Table 1 (using Planck's energy equation $E = hc/\lambda$ and the proper conversion units) reveal empirical relationships worthy of note. Thus, it can be shown that the 5-hydroxy derivatives of tryptophan, tryptamine, or indoleacetic acid absorb less energy for activation than the parent compound by an amount equal to approximately ¼ electron volt (≃ 5.75 kcal/mole); conversely, the activated 5-hydroxyindole compound emits more fluorescent energy than the parent compound by an amount equal to approximately ⅛ electron volt (≃ 2.88 kcal/mole). Such calculations may be useful for purposes of identification of compounds of this type.

Spectrophotofluorometric data were obtained for 5-hydroxytryptophan, serotonin, 5-hydroxyindoleacetic acid, their parent analogs, and compounds of re-

Table 1. Spectrophotofluorometric data on 5-hydroxyindoles and related compounds. Only the maximum activation and fluorescence peaks are presented in Table 1. A plot of points within the linear concentration range on the abscissa vs. the linear fluorescence intensity (*FI*) on the ordinate gives a straight line standard calibration curve. Fluorescence intensity (*FI*) equals galvanometer needle deflection (transmission scale) multiplied by meter multiplier readings on the Aminco photomultiplier microphotometer. Note that the insertion of a hydroxy group into position 5 of the indoles, tryptophan, tryptamine, and indoleacetic acid, increases the activation wavelength (*A*) by 15 mμ and decreases the corresponding fluorescence wavelength (*F*) by 15 mμ. Calculations based on this observation are discussed in the text. 1-Epinephrine bitartrate and 1-arternol bitartrate were made up in 5-percent acetic acid solution.

Compound	Wavelength maxima (mμ)		Concentration range (μg/ml)		Linear fluorescence intensity range (*FI*)
	Activation (*A*)	Fluorescence (*F*)	Constant maxima	Linear	
Indole*	280	350	0.01 → 10	0.01 → 1	0.015 → 1.47
Skatole*	290	370	0.001 → 10	0.001 → 1	0.005 → 1.36
1-Tryptophan*	280	355	0.001 → 10	0.1 → 7	0.075 → 1.65
5-Hydroxytryptophan†	295	340	0.001 → 10	0.001 → 5	0.015 → 5.20
Tryptamine-HCl*	280	355	0.001 → 10	0.005 → 7	0.008 → 5.3
Serotonin†	295	340	0.001 → 10	0.005 → 5	0.015 → 3.2
Indoleacetic acid*	285	360	0.001 → 10	0.001 → 3	0.015 → 3.8
5-Hydroxyindoleacetic acid‡	300	345	0.001 → 10	0.001 → 1	0.026 → 1.30
Lysergic acid diethylamide bitartrate§	320	430	0.001 → 10	0.005 → 7.0	0.013 → 15.0
1-Epinephrine bitartrate‖	280	320	0.18 → 18.2	0.18 → 18.2	0.023 → 0.87
1-Arternol bitartrate‖	280	320	0.02 → 20	0.2 → 20	0.022 → 0.96
Indoxyl acetate#	285	375	Measured only at 50 μg/ml		
Indoxyl**	310	395	Measured only at satd. soln.		
2,3-Dihydroxy indole**	315	400	Measured only at 5 μg/ml		
Oxindole**	300	345	Measured only at 5 μg/ml		
2-Methyl indole**	280	355	Measured only at 5 μg/ml		

* Eastman. † Nutritional Biochemicals. ‡ Upjohn. § Sandoz. ‖ Winthrop-Stearns. # Mann. ** Bios.

lated psychopharmacological interest by means of the Aminco-Bowman scanning spectrophotofluorometer. The instrument was calibrated to an activation reading of 350 mμ and a fluorescence reading of 450 mμ for quinine at a concentration of 0.1 μg/ml dissolved in 0.1*N* H_2SO_4. Data obtained were (i) activation and fluorescent maxima, (ii) the widest optimal range for measurement of concentrations in which these maxima were constant, and (iii) that range of concentrations (within the afore-mentioned range) that gave a linear response curve as measured by fluorescence intensity. Standard linear calibration curves for each of the compounds tested could then be plotted. Calculations revealed that the 5-hydroxyindoles absorb less energy for activation and emit more fluorescent energy in the activated state than the parent indole compounds.

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Photoscanning Detection of Radioactive Tracers in vivo

Previously described scanning methods that provide a graphic representation of the distribution of radioactive materials within the human body have an arithmetic relationship between the gamma flux detected by the scintillation counter and the density of the resulting image (*1*). When the difference in radioactivity between the target and nontarget tissues is small, as in the case of brain-tumor localizations with iodinated human serum albumin, this type of equipment fails to delineate clearly the areas of abnormal concentration.

This preliminary report describes apparatus that was designed to give maximum contrast for a minimum difference in activity. This apparatus provides good definition with small dosages and an absence of background fogging without loss of significant data. It differs from the apparatus described by Kuhl *et al.* (*2*) in that even higher contrast can be obtained with equipment readily available in the average isotope laboratory, without the necessity for manufacturing a special electronic amplifier. The examples of clinical studies shown are representative of many such studies that have been performed with this instrument in the course of the past 18 months.

In this system, the signal from the scanning scintillation probe was fed into a single-channel pulse-height analyzer in which scattered radiation was discriminated against and by which the primary gamma emission was passed on as a signal to a count-rate meter. The output of the count-rate meter was then fed to a potentiometer-type recorder (*3*). A 20-ohm wire-wound potentiometer was mechanically coupled to the pen drive wheel of the recorder in such a fashion that maximum deflection of the recorder gave minimum resistance through the potentiometer. This potentiometer was in series with a small, tungsten-filament light source (*4*) that was mechanically fixed to the scanning probe so that the physical relationships of the two were constant. The electric supply for the tungsten filament was provided by a 6.3-v filament transformer. The light source was focused into a narrow slit by a 0.5-in. diameter Lucite rod acting as a cylindrical lens. Screen type x-ray film in an x-ray film cassette was placed beneath the light. The opaque face of the cassette was replaced by transparent red plastic 1/16 in. thick. The red plastic prevented fogging of the film from external light sources if the room lights were off, but allowed exposure of the film by the concentrated light source of the instrument. This obviated the need for a lightproof film holder.

As the probe passes over the patient's body and detects an increased gamma flux, the count-rate meter drives the recorder, which in turn removes resistance from the light circuit. In consequence, the light increases in brilliance and the film is exposed. Because of the marked dependence of light emission from a tungsten filament on changes in current, extremely high contrast is obtained, so that the net result can be a 95 percent increase in film density for a 10 percent increase in count rate.

Figure 1*A* is a photoscan of a normal thyroid with 4.5 μc of I^{131} in the gland; Fig. 1*B* is the image of a metastatic carcinoma of the thyroid with 10.3 μc in its substance, superimposed over an x-ray of the region involved; Fig. 1*C* is a lateral scan; Fig. 1*D* is an anteroposterior scan of a patient with a 2- by 1.5- by 1-cm

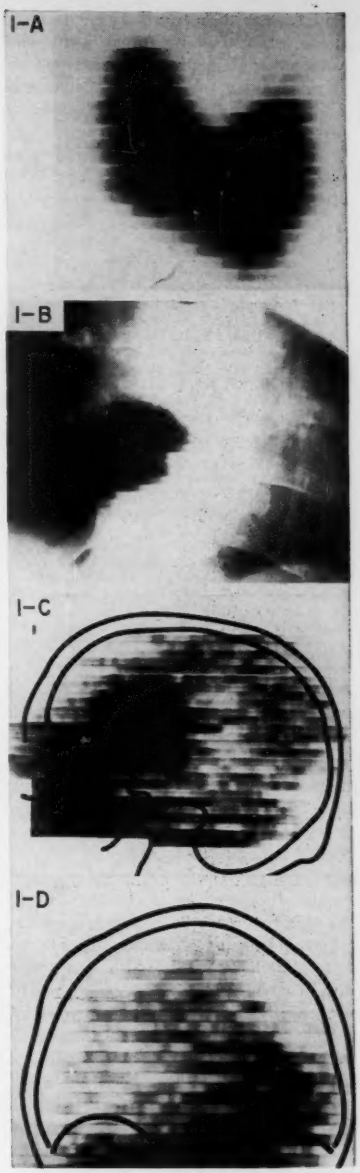

Fig. 1. Examples of the localization of *in vivo* concentrations of radioisotopes with photoscanning techniques.

cerebral metastasis to the left temporal lobe from a primary carcinoma of the breast. This patient received an intravenous administration of 300 μc of I^{131}-labeled human serum albumin 24 hours before the scan (*5*). It is important to note that the count rate over the site of the lesion was only 14 percent higher than the expected normal count rate for this position.

These studies were performed with a 1- by 1-in. sodium iodide (thallium activated) crystal having a lead collimator

with an aperture 2 in. long and 1 in. in diameter. It is hoped that a focusing collimator as described by Francis *et al.* (*6*) will increase "see-ability" and definition. Work is in progress with this type of equipment (*7*).

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4 October 1956

Nutrition of Plant-Sucking Hemiptera

The technical difficulties of culturing a plant-sucking insect apart from its host have hampered, if not effectively prevented, detailed studies of the biological relationships between sucking insects and their host plants. Many problems of importance to both agricultural and theoretical biology lie in this difficult and complex area of interest. Such problems include the breeding of resistant plants, transmission of plant pathogens, toxicogenesis, host plant specificity, insect nutrition, and many others. Although a few plant-chewing insects have been reared successfully through their life cycles on aseptic purified diets (*1*), no plant-sucking forms (aphids, leafhoppers, plant bugs, and so forth) have been so reared.

Carter (*2*) was apparently the first to devise a technique for maintaining adult leafhoppers apart from a host plant for several days. His method involved offering insects a liquid diet covered with a membrane. The leafhoppers obtained the nutrient by penetrating the membrane with their piercing-sucking mouth parts. This membrane technique has been used by a number of workers to investigate insect transmission of plant viruses, and a number of modifications have been tried. However, as far as is known to us, neither the original technique nor any of its modifications has permitted the successful rearing of the immature stages of any species of plant-sucking insect.

At the beginning of the study reported here (*3*), nymphs of a number of species of aphids, leafhoppers, and plant bugs were used in attempts to rear the insects on liquid diets covered with a large variety of membranes under a number of different environmental conditions. Although some of the insects survived such conditions for 2 or more weeks, no growth or development was observed. At least some feeding occurred, as indicated by intestinal recovery of vital dyes that had been added to some of the liquid diets. The amount of feeding was distinctly suboptimal in all cases, however. The preliminary trials showed that two hemipterous insects were well suited for further investigation, for they were hardy and could be maintained easily in stock cultures on natural food plants. These two species were the large milkweed bug, *Oncopeltus fasciatus* (Dallas) (Lygaeidae), and the one-spot stink bug, *Euschistus variolarius* (P. de B.) (Pentatomidae). Neither of these insects fed successfully under conditions in which the membrane technique or any of its numerous modifications was employed.

In all previous work on the feeding of sucking insects, it was assumed that a liquid diet and a penetrable membrane were necessary conditions for artificial feeding, and the assumption was never subjected to experimental test. Our uniform lack of success with this method led us to test the hypothesis that a liquid diet and a penetrable membrane are not necessary. Using newly hatched nymphs of *Oncopeltus* and *Euschistus*, we tried a number of different diet forms, including gels, powders, and semisolid diets. Nymphs of both species fed and grew slowly on a powdered diet that had been moistened and rolled into small pellets. Under these feeding conditions, a supplementary water source was found to be necessary; it was provided in the form of a moistened cotton wick protruding from the floor of the rearing chamber. The food material was renewed every day to minimize the effect of contamination by microorganisms and because the diets tended to harden as they dried.

Table 1. Components of a purified diet used in studies of the nutritional requirements of *Oncopeltus fasciatus* (Dallas) and *Euschistus variolarius* (P. de B.).

Constituent	Amount used	
	Wt. (g)	Percentage of dry diet
Glucose	6.25	24.3
Soluble starch	6.25	24.3
Sodium caseinate	6.25	24.3
Corn oil	1.25	4.9
Cholesterol	0.25	0.9
Mineral salt mix	0.50	1.9
Brewers yeast powder	5.00	19.4
Distilled water	15.00	0.0
Total	40.75	100.0

Several dozen different dietary formulations were tested, and the diet shown in Table 1 was the most nearly satisfactory. Both species have been reared from egg to adult on this diet. The growth obtained (Fig. 1) was suboptimal, the insects on the purified diets growing at half the rate of the controls on natural diet and attaining but about half the normal body weight. The importance of these results does not lie in the nutritional efficacy of the diets employed, but in the finding that a liquid diet and membrane barrier are not necessary conditions for feeding.

During the course of the investigation, a number of observations were made on factors that influenced the feeding behavior of the two insect species. Feeding appears to be greatly influenced by the physical and chemical conditions imposed by the diet and the rearing chambers employed. Feeding was very poor on the purified diet if the yeast powder was replaced by a mixture of B vitamins. This effect was found to be caused by (i) an unidentified attractant contained in yeast and (ii) a possible repellent effect of choline chloride. Starch stimulated feeding, whereas glucose, fructose, and sucrose did not.

Difficulty was encountered in inducing newly hatched nymphs of *Oncopeltus* to feed on the purified diets. The nymphs would feed readily on eggs of their own species and on milkweed seeds. Nymphal mortality was very high on the purified diet, except in cases where the insects were allowed to feed on eggs or seeds for a day or so immediately after hatching. This difficulty was not encountered with *Euschistus*.

The suboptimal growth obtained with the purified diets is not necessarily indicative of nutritional deficiencies. It

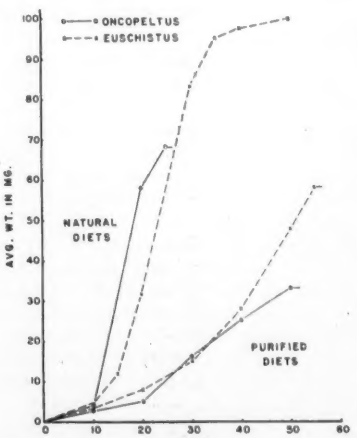

Fig. 1. Growth of *Oncopeltus fasciatus* and *Euschistus variolarus* on natural and purified diets.

seems more likely that the difficulties encountered are related to the establishment of conditions optimum to feeding. Avoiding the use of a membrane relatively impermeable to attractants and feeding stimulants is apparently an important step toward the accomplishment of optimum feeding.

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Psychopathologic Symptoms Induced by Bis-Beta-Aminopropionitrile

Several chemical substances have recently attracted much interest because of their hallucinogenic and tranquilizing effects. The purpose of our investigation was to establish whether bis-β-aminopropionitrile (Bis BAPN) (*1*) should be considered as a psychopathogenic compound.

Rats of the Sprague-Dawley (200 g) and Long Evans (280 g) strains were injected intraperitoneally with different amounts of bis-β-aminopropionitrile varying from 0.01 to 10 g per kilogram of body weight. Dosages of 4 g/kg and above were lethal within 2 to 7 days, whereas amounts below 1 g/kg caused no obvious symptoms. Levels between 1 and 2 g/kg produced the most striking psychopathologic phenomena. Immediately following injection of 2 g/kg, motor inactiveness, hypersalivation, and increased respiration were induced. For the following 48 hours the animals showed no abnormal behavior.

After approximately 2 days, the animals that had received 2 g/kg showed a marked hyperactivity. They moved their heads from side to side and twitched their necks in a manner reminiscent of patients with von Economo's encephalitis. When placed in an open space, they ran backward in a coordinated manner. If pushed forward, the rat counteracted by pushing backwards, sometimes with such a force as to produce a complete "backward somersault." The slightest touch incited a screaming that was not observed in the controls.

In all, about 80 animals were treated, with identical results. This peculiar behavioral pattern persisted for about 14 days, at which time a decline in backward running was noted. The rats moved alternately forward and backward and in the intervals frequently circled as if chasing their tails. The motor hyperactivity and head twitching persisted. The rats have remained in this condition during a 5-month period of observation; they have been able to eat and also to gain weight.

Albino mice were also injected intraperitoneally with bis-β-aminopropionitrile in a concentration of 1.5 to 2.0 g/kg. After 3 days a motoric hyperactivity became evident. The mice frequently ran in circles as if they were chasing their tails. Occasionally they moved backward and twitched their heads, but this behavior was much less pronounced than in the rats. This phenomenon resembles the genetical "waltzing" anomaly in certain breeds of white mice (*2*) and the symptoms produced by injection of β-β-iminodiproprionitrile (*3*).

Interesting psychopathologic symptoms were observed in birds (*Melopsittacus undulatus*) following a single intraperitoneal injection of 2 g/kg of bis-β-aminopropionitrile. On the third day a general hyperactivity was noted. It was characterized by persistent locomotion, excessive courtship, and compulsive eating. Other abnormalities of the motoric system were periodical circular movement and backward walking.

The behavioral pattern of fish (*Lepomus gibbosus*) can also be changed by intraabdominal injection of 2 g/kg of bis-β-aminopropionitrile. After a delay of 10 days, the fish showed periods of hyperactivity lasting for about 5 minutes, consisting of gyroscopic movements, barrel rolling, swimming on the back or on the side, and standing on the head. Afterward, the fish regained a normal position. These episodes can be produced at any time by merely touching the fish.

An exciter effect was also observed in invertebrates. Grasshoppers (*Melanoplus*) were injected intraabdominally with 1 and 2 g/kg of the same compound. When the lengths of their leaps were measured, it was found that they were significantly increased after administration of the weakest concentration. A protozoan (*Tetrahymena*) was given bis-β-aminopropionitrile in a concentration of 1/10,000 in the culture medium. When the speed with which this organism transverses the microscopic field was measured, it was found to be about twice as fast as that of the controls.

In all the tested animals, bis-β-aminopropionitrile induced a hyperactivity. The changes of the motoric system were most pronounced, but an excitation in more complex behavioral patterns, such as eating and courtship, was also observed. In addition to an acceleration of the normal behavior, the compound also produces apparently new and abnormal patterns. These abnormalities are strikingly similar to the symptoms produced by lysergic acid diethylamide (LSD-25) (*4*). Contrary to the transitory action of lysergic acid and diethylamide, the symptoms induced by bis-β-aminopropionitrile persist. The reason may be that the latter compound produces permanent alteration of the neurons of the spinal cord and brain (*5, 6*).

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6. We are indebted to F. M. Strong and J. T. Garbutt, department of biochemistry, University of Wisconsin, for supplying the Bis BAPN, and to A. D. Hasler, department of zoology, University of Wisconsin, for advice concerning the fish experiment.

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Effects of Desoxyribonucleic Acid Breakdown Products on Bacterial Population Changes and Virulence

During studies on the transformation of various strains of *Brucella* spp. by highly polymerized desoxyribonucleic acid (DNA) from genetically different strains, it has been observed (*1*) that the addition of desoxyribonuclease (DNase) to DNA-containing broth cultures causes rapid population changes from M (mucoid) or R (rough) to S (smooth). As a rule, initially non-S (avirulent) cultures of pathogenic bacteria do not undergo population changes to S (virulent) *in vitro*—that is, the gradual establishment of spontaneously arising S mutant cells in initially non-S populations is not favored (*2*). However, in susceptible hosts, or in the presence of DNA and DNase *in vitro*, such population changes (non-S to S) occur with many non-S strains (Table 1).

Studies with *Brucella* have demonstrated that the latter selective effects involve the inhibition of growth and the killing of non-S cells by a breakdown product of DNA. The breakdown product responsible for these effects does not

Table 1. Effects of DNA and DNase on population changes in initially nonsmooth bacterial cultures.

Organism inoculated	Medium	% S after 48 hours (*Pneumococcus*) or after 9 days (*Brucella*) at 37°C
Brucella abortus M	Control (beef extract broth)	< 0.01
B. abortus M	DNA* + DNase	65
Pneumococcus V-497 R	Control (brain-heart infusion broth)	< 1
Pneumococcus V-497 R	DNA + DNase	89
Pneumococcus (99.99% I-192 R + 0.001% ISVI)	Control	0
Pneumococcus (99.99% I-192 R + 0.001% ISVI)	DNA	6
Pneumococcus (99.99% I-192 R + 0.001% ISVI)	DNase	< 1
Pneumococcus (99.99% I-192 R + 0.001% ISVI)	DNA + DNase	100

* DNA from either *Brucella abortus* M or S, *Escherichia coli*, or *Pneumococcus* R.

result directly from the depolymerization of DNA by DNase but requires the additional action of S cells. Thus, the active material, which inhibits non-S cells but does not affect the growth of S *Brucella* cells, is the product of reactions that can be expressed as follows:

DNA + DNase →
X + action of S cells →
selective factor

These events were verified by several methods, including the demonstration that filtrates from S cultures that contained DNA and DNase inhibited the growth of non-S cells, whereas DNA and DNase alone did not affect the growth of such non-S cells in cultures devoid of S mutants. The source of the DNA apparently has no influence on these selective effects, for DNA isolated from either S or non-S strains of *Brucella*, from *Escherichia coli*, or from pneumococci had the same effectiveness. Inactivation studies on active filtrates indicated that the selective factor might be a nucleotide, yet none of the commercially available nucleotides, nucleosides, purines, pyrimidines, or any of their derivatives that were tested displayed any similar selective effects.

The only chemically known compound that produces similar selective effects is 6-furfurylaminopurine, or kinetin (*3*), a cell-division factor for plants. Kinetin, when it was used in concentrations below 1 μg/ml, also stimulated the selective establishment of S cells in many initially non-S populations; optimum effects were obtained at levels between 0.01 μg and 0.0001 μg/ml. However, a number of M and R strains proved resistant to the effect of kinetin, yet were susceptible to DNA and DNase, and vice versa, thus indicating that the unknown active breakdown product of DNA and kinetin are not identical. Furthermore, upon continued testing, the activity of kinetin became irregular, partially as a result of kinetin contamination of glassware; at the same time, the effects of DNA and DNase remained consistent.

In certain media, supplementation with DNase alone sufficed to promote non-S to S population changes of various *Brucella* cultures. These effects were found to be independent of differences in extracellular DNA accumulation, which occur when *Brucella* cells are grown in different media. Instead, such effects were found to be associated with highly significant differences in the ability of DNase to depolymerize DNA in different, apparently equally complex, media (*4*). Similar environmental effects on DNase activity recently were reported by Catlin (*5*).

The unique selective activities of DNA breakdown products and of kinetin are not restricted to *Brucella* cells; comparable effects have been found in recent studies with pneumococci (*6*). Here too the presence of DNA and DNase (150 μg + 75 μg/ml) favors the rapid establishment of virulent (encapsulated, nonfilamentous) mutants in growing populations consisting initially of avirulent (unencapsulated, nonfilamentous) cells only (Table 1). In the case of some nonsmooth pneumococcal strains (for example, R36A or I-192 R), the initial presence of a few S cells (<0.001 percent) is required to initiate population changes toward S (Table 1); presumably the spontaneous rate of mutation from R to S is exceedingly low in these strains.

The addition of kinetin to pneumococcus cultures has produced effects similar to those described for *Brucella*. Certain R pneumococcus cultures failed to respond to DNA and DNase, but underwent rapid population changes toward S in the presence of a *mixture* of nucleosides, DNA, and DNase. *Single* nucleosides only partially activated the effects of DNA and DNase in these systems. Depending on the strains employed, DNA and DNase either enhance the growth of S cells selectively, inhibit the multiplication of R cells, delay the autolysis of S cells, enhance the autolysis of R cells, or cause a combination of these effects. These selective effects of DNA breakdown products on R to S population changes of pneumococci are independent of the source of DNA employed and should not be confused with the specific R to S transformations obtainable with polymerized pneumococcus DNA (*7*).

Table 2. Effects of DNA and DNase on the virulence of pneumococci (ISVI) for mice.

Animal group*	No. of cells injected per mouse	Percentage dead after					
		24 hr	36 hr	48 hr	60 hr	72 hr	15 days
Untreated	88			0	10	20	20
Untreated	880		0	10	30	40	40
Untreated	8800		0	30	50	60	70
DNA + DNase† at time of infection	88		0	80	100	100	100
DNA + DNase at time of infection	880		0	70	100	100	100
DNA + DNase at time of infection	8800	20	80	100	100	100	100
DNA + DNase 24 hr before infection	88		0	100	100	100	100
DNA + DNase 24 hr before infection	880	0	10	70	100	100	100
DNA + DNase 24 hr before infection	8800	10	70	100	100	100	100
DNA + DNase 24 hr after infection	88				0	100	100
DNA + DNase 24 hr after infection	880			0	10	100	100
DNA + DNase 24 hr after infection	8800			90	100	100	100
Purine pool‡	880			0	10	30	30
Purine pool	8800			40	60	80	80
DNA + DNase, DNA alone, DNase alone, or purine pool				0	0	0	0

* 10 animals per group. † 450 μg of DNA and 200 μg of DNase per mouse. ‡ 3 mg of adenine, 3 mg of guanine, 3 mg of xanthine, and 15 mg of hypoxanthine per mouse.

DNA and DNase not only promoted the establishment of virulent cell types *in vitro* but also exerted an effect on the virulence of S pneumococci *in vivo*. A single subcutaneous (dorsal) administration of 450 μg of DNA and 200 μg of DNase per mouse, either at the time of intraperitoneal infection, 24 hours prior to infection, or 24 hours after infection significantly reduced the survival time and the LD_{50} (Table 2). This virulence-enhancing effect of DNA and DNase appears to be quite different from previously reported effects of purines on the virulence of purine-requiring mutants of *Salmonella, Erwinia, Klebsiella,* and *Agrobacterium* (*8*), for the injection of a purine pool did not affect the survival time of mice infected with pneumococci.

In studies with *Brucella*, desoxyadenosine and sonic extracts of S *Brucella* cells have shown some antagonistic activity toward the S-selecting effects of DNA and DNase *in vitro*. Further studies with these and other antagonists, as well as studies on the chemical nature of the active DNA breakdown product and its mode of action, are now in progress (*9*).

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22 October 1956

Paper Electrophoresis of Avian and Mammalian Hemoglobins

As was reported previously (*1*), chick hemoglobin reveals two components on electrophoretic analysis. These components are present in varying proportions, depending on the age of the chick. In view of these findings, it was considered of interest to investigate the electrophoretic behavior of the hemoglobins of birds for comparison with hemoglobins of certain mammalian species. Accordingly, the hemoglobins of the pigeon (*Columba livia*), duck (*Anas*), guinea fowl (*Numida melagris* Linn.), and chick (*Gallus gallus*) and of man (one normal and two cases of Hb-E-thalassemia), cow, goat, and rabbit have been investigated in an LKB paper-electrophoresis apparatus using barbiturate buffer of *p*H 8.6 and of ionic strength 0.05.

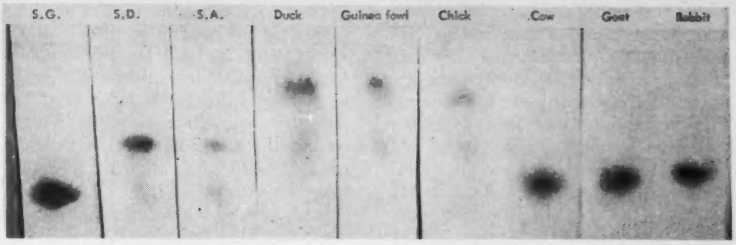

Fig. 1. Paper electrophoresis of avian and mammalian hemoglobins in barbiturate buffer (*p*H 8.6; ionic strength, 0.05) at 220 v applied for 15 hours. Samples S.A. and S.D. were taken from human patients with hemoglobin E-thalassemia; sample S.G. was taken from a normal human adult.

Blood was collected from the jugular vein and was washed with isotonic saline and treated in the usual way (*2*). The hemoglobin solutions thus obtained were centrifuged at 10,000*g* for 15 minutes at 5°C and diluted to a 5-percent solution before electrophoresis. The solutions were kept at −15°C and thawed prior to the electrophoretic runs. The electrophoretic runs were conducted at 220 v for 15 to 18 hours. The electrophoregrams were scanned photometrically at 540 mμ by means of a Photovolt densitometer model 525.

Figure 1 represents the relative positions of the hemoglobins of the rabbit, goat, cow, chick, guinea fowl, duck, two men suffering from hemoglobin E-thalassemia (S.A. and S.D.) and a normal human adult (S.G.).

During this study, it was observed that the blood of the mammals, including the normal human adult, showed only one component (Hb-A), while that of the different birds investigated showed two hemoglobin components. The one moving more slowly toward the anode may be called component 1 and the one moving faster may be called component 2. The percentage composition of each of the two components was evaluated from the density curve by means of a planimeter, and it was found that the proportion of the component 2 was always less. None of the hemoglobin components of the avian blood is identical with the mammalian hemoglobins. Component 2 of avian hemoglobin appears to be identical with hemoglobin E—that is, the special hemoglobin component which is present in the blood of the patients with hemoglobin E-thalassemia. Confirmation that the slower moving component in the blood of these patients referred to here is hemoglobin E (*3*) has been provided independently (*4*). The proportions of components 1 and 2 in avian blood vary from one species to another. The relative mobilities of hemoglobin A in cases of rabbit, goat, cow, and the human beings S.A., S.D., and S.G. were found to be 3.4, 3.6, 3.6, 3.5, 3.5, and 3.6, respectively. The relative mobilities of component 1 and component 2 in chick, guinea fowl, duck, and pigeon blood were found to be 1.0, 1.0, 1.0, and 0.7, and 2.5 2.5, 2.5, and 1.2, respectively. The relative mobility of hemoglobin E in the two cases referred to here was found to be 2.5. The relative mobilities were calculated as centimeters per volt, per second.

Experiments on the rates of alkaline denaturation of the hemoglobins of different species as carried out according to the technique of Singer *et al.* (*5*) indicate that there is no special relationship in this respect between the mammalian and the avian hemoglobins. Even the closely related groups, such as chick and guinea fowl, which are classified under the same order, show varying resistance to alkaline denaturation, the chick hemoglobin being more resistant than guinea-fowl hemoglobin.

Further electrophoretic studies on the hemoglobins of birds such as koel (Cuculidae) and parakeet (Psittacula) revealed the presence of only one hemoglobin component which corresponds to the component 1 of avian hemoglobin, whereas the crow (Corvidae) hemoglobin behaves similarly to the chick hemoglobin. Although the frog and the chameleon hemoglobins undergo a great deal of denaturation during the electrophoretic runs, they reveal the presence of two components. Comparative study of avian hemoglobins by means of paper electrophoresis provides us with the relationship and the evolutionary trends maintained in the chief groups of the birds (*6, 7*).

It is of interest to speculate whether the presence of hemoglobin E in thalassemic patients and in the different avian species is an indication of a common ancestry of mammals and birds, hemo-

globin E being retained as a genetic trait in thalessemic human beings, while it has practically disappeared from the blood of mammals generally, or whether it is the result of similar type of physiological adjustment that occurs in birds and in thalassemic human beings.

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Multiplication of Poliovirus in Reticuloendothelial Cells without Generalized Cytopathogenic Effect

With a technique previously described (*1*), we obtain from the peritoneal exudate, artificially produced in cynocephalus monkeys, living *in vitro* cultures of reticuloendothelial cells. These cultures, prepared in flattened tubes, show after 4 to 5 days a quite homogeneous population of histyocyte-macrophage type of cells established on the surface of standard-size cover slips that are introduced into the flattened part of the tube. The number of cells in 1-week-old cultures is approximately 10^5; this is of the same order of magnitude as that obtained in cultures of trypsinized monkey kidney cells prepared in the usual way in the same kind of tubes (*2*).

One monkey can provide enough exudate to prepare 40 to 50 cultures at one time, and it can be used again as a source of cells after a 7- to 10-day period of rest. Experiments with poliomyelitis virus were performed with the Mahoney type I strain. One thousand $TCID_{50}$ were introduced into each tube in 1 ml of medium, usually on the first or the second day of the culture.

No definite cytopathogenic effect was seen in the infected cultures observed during 8 and, in some cases, during 13 days, after introduction of the virus. Moreover, the acidification of the medium was progressing in these cultures at the same rate as it was in the noninfected controls. In cultures of monkey kidney cells that were infected simultaneously with the same virus concentration, the acidification of the medium was inhibited, and all cells were destroyed in 3 days.

In fixed and stained preparations of the cultures of reticuloendothelial cells 4, 6, 8, and 13 days after introduction of the virus, one can observe a nearly normal population of histiocytic cells, most of them having clear nuclei, distinct nucleoli and numerous cytoplasmic ramifications (Fig. 1). No typical poliomyelitis lesions, as they were described in human fibroblasts (*3*) or in human and monkey epithelial cells (*4*), are present.

Titrations performed with the supernatant fluid of the exudate cell cultures reveal that, despite the apparent lack of cytopathogenic effect, the virus is multiplying and is released in the medium. The virus introduced at the start at a concentration of 10^3 ID_{50} per milliliter is no longer detectable after 48 hours in control tubes without cells, while in the presence of exudate cells, this concentration rises to 10^5 to $10^{5.5}$ ID_{50} per milliliter and remains at a level of 10^5 to 10^6 ID_{50} per milliliter during at least 8 days despite complete renewal of the medium on the third and the sixth days. It is apparent, therefore, that release of virus by the cells is nearly continuous during this period.

It is permissible to conclude from these experiments that a culture of monkey reticuloendothelial cells reacts in a quite different way from a similar monolayer culture of dispersed epithelial or fibroblastic cells when infected with the same concentration of virus. Two possible explanations can be put forward:

1) Only a small proportion (less than 10 percent) of the cells in the reticuloendothelial cultures is available for infection and virus reproduction. If so, the specific destruction of the virus-infected cells would be difficult to observe even if present (*5*). One would then have to admit that, during the culture period, new cells are permanently coming to maturity in the sense of receptivity to virus. The mechanism of this possible maturation is not clear, but a similar phenomenon was noted *in vitro* with other freshly explanted tissues (*6*).

2) The other possibility is that the individual infected reticuloendothelial cells produce and release the virus in a more continuous and less explosive way than the epithelial or fibroblastic cells, and that virus reproduction in these cells is not necessarily associated with cell destruction.

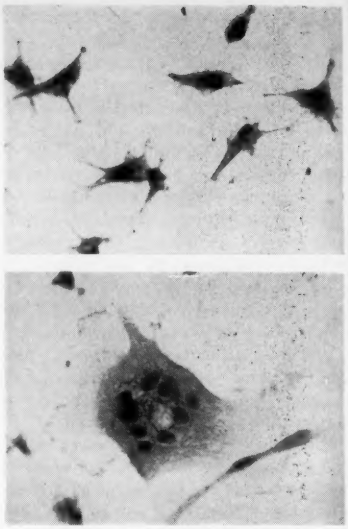

Fig. 1. Eight-day culture of monkey peritoneal exudate cells, 7 days after introduction of 1000 ID of poliovirus. The virus titer of the culture fluid on the day of cell fixation was 10^6 ID_{50} per milliliter. (Top) normal histiocytic cells; (bottom) normal giant cell.

Anyhow, these experiments afford direct proof that polio virus can multiply *in vitro* in a population of reticuloendothelial cells that have been taken from a polio-sensitive species without any generalized cytopathogenic effect. These observations corroborate by an *in vitro* test the numerous data (*7*) obtained on the living animal concerning the massive poliovirus multiplication localized during the first stage of infection, most probably in the elements of the reticuloendothelial system that are connected with the alimentary tract without evident histological lesions.

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26 November 1956

Book Reviews

Spectroscopy at Radio and Microwave Frequencies. D. J. E. Ingram. Philosophical Library, New York, 1956. 332 pp. Illus. $15.

The rapid and extensive development of spectroscopy in the radio-frequency and microwave regions during recent years has created an important demand for review articles and textbooks in these fields. This most recent addition to the still limited number should be welcome and useful. The author sets out to cover essentially all radio-frequency and microwave spectroscopy at a level appropriate for the nonspecialized worker or student of physics. He achieves worth-while but limited success, partly because this is a small book and partly because a penetrating treatment and optimum choice of material in such a wide range of fields would require slightly superhuman ability. The book does consider and discuss techniques and elementary theory of microwave spectroscopy of gases, electronic paramagnetic resonance, ferromagnetic resonance, molecular and atomic beams, nuclear paramagnetic resonance, nuclear quadrupole resonance, and their applications to various fields. It provides useful, brief discussion and a handy summary of results obtained as well as a liberal supply of references.

The book has several faults, which I will mention in order of increasing importance. First, the author is apparently not sufficiently familiar with the literature in some areas of the wide fields he covers to specify unerringly the sources of various contributions to the developments discussed. This fault is probably important only to those contributors who may feel slighted and sensitive. Second, his lack of perspective is disappointing. To quote from the preface, he evidently planned "a broad approach" to radio-frequency and microwave spectroscopy, and "a critical review." The approach is broad in that he mentions a wide variety of topics, but hardly critical or penetrating. Nor is the treatment balanced in the amount of space given to various topics. Molecular and atomic-beam spectroscopy is treated in 10 pages and nuclear paramagnetic resonance, in 20, whereas electronic paramagnetism is allotted nearly 70. This makes the treatment of electronic paramagnetic resonance particularly good, but that of some other fields distinctly minimal. Finally, there are some important errors. For example, Table 9.1, which summarizes the usefulness of the various techniques in yielding physical information, contains both misleading and incorrect statements. Similarly, the paragraph on measurement of nuclear magnetic moments by Zeeman effects in gaseous spectroscopy is almost completely incorrect. Such errors can be very misleading to someone who dips casually into this volume for orientation and guidance.

In spite of such definite limitations, the book is interesting and informative. It should be helpful to anyone wanting a quick view of modern research in radio-frequency and microwave spectroscopy, and also to those who are somewhat more deeply interested in the active and valuable field of electronic paramagnetic resonance.

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Therapeutic Use of Artificial Radioisotopes. Paul F. Hahn, Ed. Wiley, New York; Chapman & Hall, London, 1956. 414 pp. Illus. $10.

Despite the availability of radioactive materials, Paul Hahn points out in the preface of this book that "tremendous strides" in the treatment of malignant disease have not been made. Criticism of past research is not a feature of this book, although Hahn stresses the need for new and ingenious ways to use isotopes in therapy.

The editor is the senior author of chapters dealing with the production and handling of isotopes, the use of radioactive colloids in chronic leukemia, and the use of silver-coated radioactive colloids as adjuvants in the surgical treatment of bronchiogenic carcinoma. Introductory chapters, written by G. Hevesy, C. W. Sheppard, and by A. Aaran Yalow, dealing with the problems of therapy, physics, and dosimetry help prepare the reader for the more practical chapters which deal with particular facets of radioisotope therapy in man. D. L. Tabern's chapter dealing with the availability and procurement of isotopes includes photographs of the forms necessary to secure radioisotopes from the U.S. Atomic Energy Commission.

Hymer L. Friedell and Paul Salerno present the one chapter based only on research data in laboratory animals. In this the differences in the distribution of radioactive materials in the liver, spleen, and bone are correlated with some of the biologic effects of mixtures of radioactive materials. Other chapters deal with the techniques of radioactive isotope therapy which have been used with varying degrees of success in human beings. Edwin E. Osgood is the author of a chapter which discusses in detail the use of phosphorus-32 in the treatment of leukemia and polycythemia. Osgood does present follow-up statistics for a large group of treated patients.

The techniques of using radioactive colloids is emphasized in this book. J. H. Muller of Switzerland discusses the intraperitoneal application of radiocolloids in patients with neoplasms involving the peritoneum. Gould A. Andrews of the Oak Ridge Institute of Nuclear Studies discusses the treatment of pleural effusion secondary to neoplasms with radioactive colloids. These chapters outline well the techniques for the use of radioactive colloids for the therapy of serous effusions secondary to neoplasms. The use of radioactive colloids to treat serous effusions secondary to neoplasms is more widely accepted than is the local interstitial use of radioactive colloids in and adjacent to neoplasms.

Separate chapters by authors with unique experience in using radiocolloids in carcinoma of the uterine cervix and carcinoma of the prostate are presented. The use of radioactive colloids interstitially in tumors and adjacent tissue may have value alone or when combined with other types of therapy such as surgery. Uniform distribution of the colloid in tumor and adjacent tissue is difficult to achieve. Often the uptake of the interstitially administered material is less in nodes containing large aggregates of tumor than it is in normal lymph nodes. In a chapter dealing with the use of radioactive colloids in carcinoma of the lung, Hahn recommends the techniques as an adjuvant to surgical treatment. The authors' collective experience with radioactive colloids is extensive and the record of this experience is perhaps the best part of this book.

Several of the chapters are written by British scientists as follows: D. W. Smithers, D. M. Wallace, and N. G. Trott discuss their use of bromine-82 in an intraluminal rubber bag to treat carcinoma of the urinary bladder. The only chapter dealing entirely with nonneoplastic lesions is that on the treat-

ment of thyrotoxicosis by radioiodine by N. B. Myant. E. E. Pochin writes the chapter on the use of iodine-131 in the treatment of thyroid carcinoma. M. Lederman and W. K. Sinclair describe application of beta and gamma emitters to superficial lesions. Special emphasis is given to the therapy of superficial lesions of the eye in this chapter.

The use of small "seeds" of cobalt-60 and gold-198 locally is discussed by U. K. Henschke. G. H. Fletcher is the author of a chapter dealing with the use of cobalt-60 as an external radiation source.

The emphasis of this book is on the techniques and effects of artificial radioisotopes as internal emitters. Too few of the authors present follow-up data for sizable groups of patients treated. Although the techniques may not be used in the same fashion as they are presented, the experience recorded will help direct further efforts in therapy with radioactive materials.

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The Biochemistry and Physiology of Bone. Geoffrey H. Bourne, Ed. Academic Press, New York, 1956. 875 pp. Illus. $20.

This treatise has been gathered from the contributions of numerous authors from many countries and with diverse academic and scientific associations. It exemplifies the wide range of modern interest in the study of bone and related structures and recapitulates the long-standing concern with, and appreciation of, the complexities of these tissues in comparative zoology, general anatomy and histology, embryology, growth and development, experimental research, and pathology. These studies have been considered by the various authors in separate sections which are more or less comprehensive. This results in a certain degree of overlap which, though inevitable, is not necessarily disadvantageous.

The primary constituents of bony tissues are reviewed from the standpoint of anatomy only in the broader sense of bone types and development. The more particularized discussion of cancellous and compact bone as organized structures is based on research with the modern tools of biophysics, chemistry, and histochemistry. Ground substance of connective tissue and cartilage, the organic matrix of bone, collagen fibers of connective tissue, and the ultrastructure and distribution of mineral salts represent a few of these special studies. The osteoblast and osteoclast are discussed from the standpoint of general cytology and also on the wider basis of histochemistry and physiology. The role of phosphatase, the occurrence of citric acid, the process of calcification, and autoradiographic features of bone formation and growth are described in the human embryo and fetus, in tissue culture, and in relation to structural and physiologic controls of growth and development. Repair and transplantation effects with induction form a related, if separate, consideration.

The effects of vitamins A, C, and D on fibers, ground substance, cartilage, and bone are fully discussed, both in their manifestations when they are deficient and also for the additional information that can be gained from the effects that their lack or excess have in broader fields of bone chemistry, physiology, and biology.

The hormones including ovarian, testicular, and adrenal cortical steroids, the anterior pituitary, thyroid and parathyroid regulation of skeletal growth, development and homeostasis are well presented. Many of these features are necessarily experimental and based on comparative studies, as are the effects of radioisotopes and external and internal irradiation. The last section has more detailed clinical data than do other sections of this treatise and includes a more comprehensive survey of marrow and hematopoietic tissue as affected together with bone under a wide range of conditions. The mark of the atom is well documented in other chapters but finds one of its more interesting and important expressions in the sections on osteodysplasia and neoplasia associated with radiation effects.

Relations between electrolyte imbalance, matrices, cells, aging processes, and pathologic calcification are given general consideration. This work is a general and comprehensive one and is not primarily designed to present the pathology of bone and dental structures, even though alterations in their biochemistry and physiology are essentially reflections of such processes.

The illustrations, tables, and bibliography are good and cover the immense field well. The treatise can be recommended for the importance it should have for any discipline concerned with the subject of bone and related structures.

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Photosynthesis and Related Processes. vol. II, pt. 2. *Kinetics and Photosynthesis;* addenda to vol I and vol. II, pt. 1. Eugene I. Rabinowitch. Interscience, New York, 1956. 877 pp. Illus. $18.50.

With this volume Eugene I. Rabinowitch brings to a close his comprehensive review, of which volume I was published in 1945 and volume II, part 1, in 1951. The present book completes, in chapters 31–34, the discussion of kinetics of photosynthesis, with chapters on the temperature factor, the pigment factor, and various time effects, including induction phenomena and the effect of intermittent light. The rest of the book consists of addenda to the previous volumes, with chapters on two areas of knowledge in photosynthesis which have been greatly enlarged in recent years: photochemistry of chlorophyll and the chemical path of carbon dioxide. A final chapter, covering a number of topics, brings all phases of the review up to date as of 1955.

By means of the addenda the author has succeeded admirably, both in completing his intended broad coverage of subject matter and in producing an up-to-date work. The difficulties to be overcome in achieving these objectives will be appreciated by those familiar with the recent rapid progress in research in photosynthesis. Moreover, it would seem that this final volume has appeared at an opportune moment. The chemical pathway of carbon in photosynthesis is just becoming clearly known, while the mechanisms of the primary photochemical reactions and of oxygen evolution from water remain subjects of speculation built around scattered but promising bits of evidence.

The author has held to his policy of discussing all alternative theories and significant experiments. One result of this is that the final volume brings the entire review to more than 2000 pages. While some of the pages of earlier volumes could, no doubt, be eliminated at this date, the organization of the complete work is such that the two previous volumes must be available to permit full use of the present one as a reference work. However, in some sections recent progress so outweighs earlier work that reference to the first two books would be chiefly for historical reasons. Reference use is facilitated by the inclusion of a rather detailed table of contents and author index for this volume, and a 66-page subject index for all three volumes.

Progress in the past decade in elucidation of the chemical path of carbon in photosynthesis is described in some 70 pages. Unfortunately, some of the arguments which led to the present form of the carbon reduction cycle are nearly lost in the account of the interesting historical development. For example, the support given the proposed sugar phosphate rearrangements by the sugar degradation data on page 1672 is never fully discussed, although these rearrangements are of key importance in the cycle.

Among the many interesting topics reviewed in chapter 37, I shall mention, here, only the very significant discoveries regarding the structure and composition of chloroplast and subchloroplast particles. Electron miscroscopy has been particularly revealing in this connection,

and a number of micrographs have been beautifully reproduced in this chapter. This work has inspired a number of interesting proposals for the structure of the photochemical apparatus and its mechanism of action.

The book concludes with a lucid epilog summarizing the current status of knowledge of photosynthesis. This section includes four more outstanding electron micrographs of chloroplast sections. The author's expressed hope that this monograph will not rapidly become obsolete seems well justified. Even if progress in our understanding of photosynthesis continues at its present rapid pace, it is likely that this volume will be useful to the research worker for a number of years and will, in fact, contribute substantially to that progress.

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International Review of Cytology. vol. V. G. H. Bourne and J. F. Danielli, Eds. Academic Press, New York, 1956. 570 pp. Illus. $11.50.

This is the fifth volume in an annual series whose aim, as it is expressed in the editor's foreword, is to survey "the whole of cytology and cell physiology in order to enable those interested in cell biology to form more easily a unified concept of the field." Fourteen independent reviews, dealing primarily with animal cells or microorganisms, are included. These papers encompass broad problems of cellular organization in relation to metabolism, growth, development, differentiation, and heredity. Structural patterns are considered at the molecular, particulate, and cellular levels; functional relations are stressed throughout the book, with reference to underlying physical or chemical mechanisms. The contributors have been selected from seven different countries; by this criterion, "the *International Review of Cytology* has become increasingly international." It has also become increasingly expansive over the years.

The individual contributions include topics as diverse as the chemical composition of the bacterial cell wall (C. S. Cummins) and the cytology of spermatogenesis (V. Nath). There are also articles dealing with intracellular *p*H (P. C. Caldwell), activity of enzymes in red cells (T. A. J. Prankerd), uptake and transfer of macromolecules (A. M. Schechtman), protoplasmic contractility in relation to gel structure (D. Marsland), the acrosome reaction (Jean Dan), and cell secretion (L. C. U. Junqueira and G. C. Hirsch), which reflect many different aproaches to problems of cell physiology. Reviews on theories of enzyme adaptation (J. Mandelstam) and cytophotometry in the study of nuclear DNA (R. and C. Vendrely) consider problems of special interest to geneticists. In addition, there are reviews dealing with the use of labeled antibodies in histochemistry (A. H. Coons) and with the structure and properties of cellular organelles, including mitochondria (J. W. Harman; W. Andrew) and cytomembranes (F. S. Sjöstrand), that reveal current interests and activities in cytochemistry and electron microscopy. Obviously, there is something here for almost every cytologist, *chacun à son goût*.

As is usual in a compilation of this type, the individual contributions vary greatly with respect to breadth of literature survey and intensity of analysis. At one extreme, little more is recorded that the historical background and a catalog of recent findings; at the other, one is presented with a thoughtful evaluation of current information and a perspective of unsolved problems of general interest. There is a measure of overlapping in coverage of subject material (in accordance with a stated editorial policy), which serves to bring into sharper focus areas of conflicting opinion (the reality of the mitochondrial membrane, the function of the acrosome, and so forth) and to emphasize the need for further exploration. The reproduction of electron micrographs, although reasonably good in this book, must be better in future volumes if the reader is to be privileged to assess critically the pictorial evidence on which are based important conclusions and generalizations about extremely fine cellular structure. Typographic errors are relatively few, but occasional lapses in respect to clarity of expression and precision of scientific terminology could have been avoided through more rigorous editing.

Despite minor imperfections, this book might profitably be studied by every student of cellular biology who seeks information about accomplishments in areas beyond his special sphere of research activity. The *Review* is intended "to emphasize the unity of cytology," and cytologists will probably agree that these 14 papers serve to illustrate the diversity of techniques and talents now being utilized in the ever-widening search for a better understanding of the properties of the living cell.

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New Books

National Science Foundation, Sixth Annual Report for the Fiscal Year Ended June 30, 1956. National Science Foundation, Washington, 1956 (order from Supt. of Documents, GPO, Washington 25). 189 pp. $0.75.

Atoms and the Universe. An account of modern views on the structure of matter and the universe. G. O. Jones, J. Rotblat, G. J. Whitrow. Scribner's, New York, 1956. 254 pp. $4.50.

Analytical Pathology. Treatises in the perspective of biology, chemistry, and physics. Robert C. Mellors, Ed. Blakiston Div., McGraw-Hill, New York, 1957. 477 pp. $12.

Nonparametric Methods in Statistics. D. A. S. Fraser. Wiley, New York; Chapman & Hall, London, 1957. 299 pp. $8.50.

Modern Introductory Physics. Ira M. Freeman. McGraw-Hill, New York, ed 2, 1957. 497 pp. $6.

Fundamentals of Physics. Henry Semat. Rinehart, New York, ed. 3, 1957. 914 pp. $8.

XVth International Congress of Pure and Applied Chemistry. Main Congress lectures and lectures in the sections. Birkhauser, Basel, 1956. 240 pp. F. 32.

Symposium Sulla Eparina. Milan, 19 December 1955. Organizzato dalla Lombarda di Scienze Mediche e Biologiche. Stamperia Cesare Tamburini, Milan, 1956. 263 pp.

College Writing. A functional approach to college composition. Cecil B. Williams and John Ball. Ronald Press, New York, 1957. 475 pp. $3.75.

Quantum Chemistry. An introduction. Walter Kauzmann. Academic Press, New York, 1957. 744 pp. $12.

The Enjoyment of Mathematics. Selections from mathematics for the amateur. Hans Rademacher and Otto Toeplitz. Translated by Herbert Zuckerman. Princeton University Press, Princeton, N.J., 1957. 204 pp. $4.50.

Microcalorimétrie. Applications physico-chimiques et biologiques. E. Calvet and H. Prat. Masson, Paris, 1956. 395 pp. Paper, F. 4500; cloth, F. 5200.

Integrated Anatomy and Physiology. Carl C. Francis and Gordon L. Farrell. Mosby, St. Louis, ed 3, 1957. 641 pp. $5.85.

Electrical Measurements and Their Applications (based on *Advanced Electrical Measurements,* 1932, 1941). Walter C. Michels. Van Nostrand, Princeton, N.J., 1957. 331 pp. $6.75.

Climate and Economic Development in the Tropics. Douglas H. K. Lee. Harper (for the Council on Foreign Relations), New York, 1957. 182 pp. $3.50.

The Grenville Problem. Royal Society of Canada Special Publs. No. 1. James E. Thomson, Ed. University of Toronto Press and The Royal Society of Canada, Toronto, 1956. 119 pp. $3.95.

Plant Propagation. John P. Mahlstede and Ernest S. Haber. Wiley, New York; Chapman & Hall, London, 1957. 413 pp. $7.50.

How to Prospect for Uranium. Hubert L. Barnes. Dover, New York, 1956. 117 pp. $1.

Handbuch der Physik. vol. XXXV, *Atoms I.* 454 pp. DM. 99.50. vol. XXXII, *Structural Research.* 603 pp. DM. 144. S. Flugge, Ed. Springer, Berlin, 1957.

Why Wages Rise. F. A. Harper. Foundation for Economic Education, Inc. Irvington-On-Hudson, N.Y., 1957. 124 pp. $1.50.

Meetings and Societies

Calder Hall Nuclear Power Station

As is well known, the first regular supply of electric power from nuclear energy was fed to the supply mains of Great Britain when Her Majesty the Queen opened the Calder Hall Station on 17 Oct. 1956. This was a great occasion for the United Kingdom Atomic Energy Authority; indeed it can almost be regarded as a historic occasion. However, from a scientific point of view another occasion of outstanding importance was the meeting of the British Nuclear Energy Conference in London on 22–23 Nov., when the whole detailed story of the design and construction of the Calder Hall plant was placed on record.

The interest shown in this meeting is well indicated by the size of the audience, more than 2000 members being present, and by the fact that large contingents from overseas countries journeyed to London to take part in the meeting. These overseas visitors included parties from the United States, from Sweden, France, Italy, Belgium, and many other European countries, and from other parts of the world. It was particularly gratifying to receive the good wishes and congratulations of the American visitors and to know that the work done so far in England has stimulated interest in gas-cooled reactors in the United States. The studies which are being made of the advantages of gas-cooled reactors as compared with the pressurized-water reactors will be of outstanding interest when they are available for publication.

The symposium itself was divided into five sessions, with the chairman of the conference, Sir John Cockcroft, presiding over the opening session, the second session on technical research problems, and the final discussions summarizing the proceedings and considering future developments. W. L. Owen, engineering director of the industrial group which was responsible for building Calder Hall, was chairman of the session on engineering design. The session on light engineering and electrical engineering was presided over by J. Eccles (Central Electricity Authority). Although this session included very little material related to the electric supply industry, it seemed appropriate that the Central Electricity Authority should provide the chairman for one session in view of the very close association between that authority and the Atomic Energy Authority in the development of nuclear power in Great Britain.

In a meeting of this size, with some 20 papers presented, some in rather general form and some more detailed, obviously a few papers will attract the most public interest. The unique feature of the conference was undoubtedly its comprehensiveness, but in presenting the meeting to a wider audience some selectivity must be shown. The student of nuclear energy will find it profitable to study the papers as a whole.

Of all the papers presented, the opening address by Sir Christopher Hinton was perhaps the most stimulating. Hinton's unique position as head of the industrial group of the United Kingdom Atomic Energy Authority, and the subject of his address, "The place of the Calder Hall-type of reactor in nuclear power generation," combined to give this paper an interest which could not be equaled by those which followed. Some of his conclusions will be regarded as debatable by some experts, but the standing that he enjoys within atomic energy circles will undoubtedly result in his views being the subject of very close scrutiny.

Hinton dealt with the early history of the British atomic energy organization and the considerations which led to the rejection of the Hanford-type of pile as a plutonium producer for the British defense project. Even in the earliest days the advantages of a reactor basically similar to the Calder Hall-type were understood and given detailed consideration. A number of factors combined, however, to lead to this type of reactor being rejected in favor of the air-cooled piles which were eventually built at Windscale and which have now been operating for 5 or 6 years.

The Calder Hall-type was not abandoned when the decision to build the air-cooled piles at Windscale was taken but was continued as the subject of a research project at Harwell. This stage of the work was described fully in later papers of the symposium. The increased requirement for plutonium for military purposes which arose later provided a suitable occasion for reexamining the Calder Hall-type of pile, primarily from the standpoint of its function as a plutonium producer, with electricity as a by-product. This made it possible to begin major engineering studies and construction at an earlier date than would otherwise have been the case and led to a detailed study of the future use of piles of this type in a long-term program for nuclear power production. The British program was the first in the world to show, comprehensively and over a long term, how nuclear energy could meet the growing need for power, and the Calder Hall-type reactors form the basis of the program.

The second half of Hinton's paper was speculative in that it forecast the trends in capital costs and weight per horsepower of nuclear power plants in the future. Although, no doubt, arguments may be raised about details, the broad conclusions can hardly be questioned. As an example, the accompanying graph shows the curve given for capital cost in pounds sterling per horsepower extrapolated to the year 2000. With arguments based on curves such as this, and indications of possible future development of this type of reactor, Hinton drew the conclusion that such reactors will find a place in nuclear power generation, at least during the next 25 years. In the second half of that period, and for particular applications perhaps even earlier, the need for reduction in total weight per horsepower will lead to the development of liquid-cooled systems.

The details of the design study and the later engineering design and construction of the Calder Hall reactors were presented, in the next two papers, by R. V. Moore, who participated in the earlier work at Harwell and was able to carry the work through to completion when he transferred to the industrial group of the UKAEA.

The four groups of industrial firms which have submitted designs to the Central Electricity Authority were represented by their leading executives, and all offered tributes to the success of the work, with perhaps at times a slight indication that industry would be glad to be given a little more initiative and freedom. The most forthright commentary came from Sir Claude Gibb, who expressed his pride in the achievement to date, to which his own group has contributed extensively, and his confidence in the future. He called emphatically for an immediate decision to augment the published program for nuclear energy utilization in the United Kingdom.

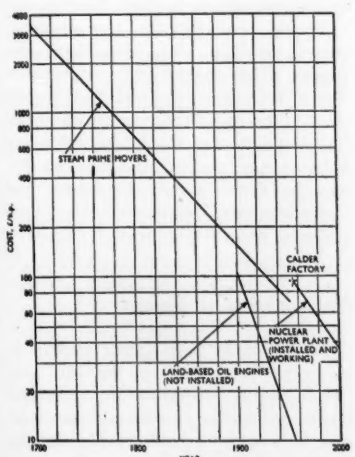
Some of the features of the newer designs of industrial reactors were outlined.

Generally speaking, economies can be achieved over the Calder Hall design by an increase in size and rating of the reactor. This leads to a reduction in capital costs, while lower operating costs are achieved by charge and discharge arrangements which can be operated on full power, thus giving a better load factor. However, development is limited by the shortage of scientists and engineers and depends, also, on the availability of suitable steel, the size pressure vessel which can be fabricated, and production of a sufficient number of materials-testing reactors.

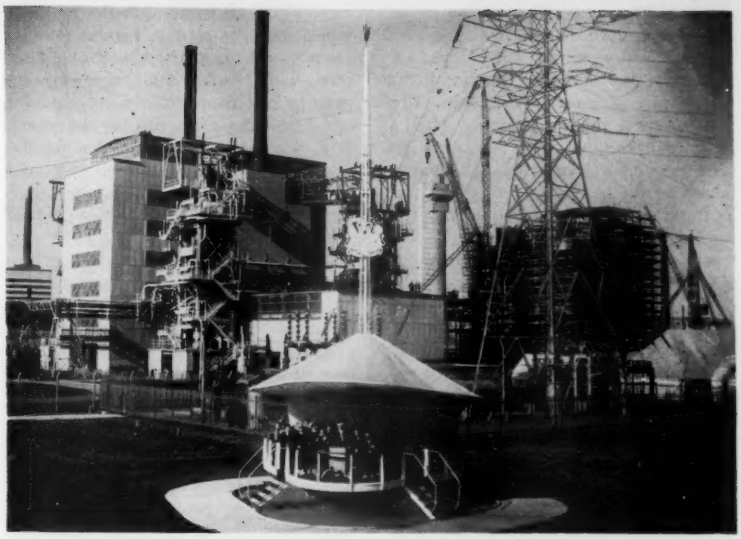
An interesting point made by Brown (Central Electricity Authority) was that, with the increasing size of units, conventional stations can produce electricity in future years at less than present-day costs. This was questioned by W. L. Owen, who pointed out that the capital cost of conventional stations was not the most important part of the cost of generation. He felt that the rising cost of the fossil fuels, coal and oil, which had persisted for half a century, would preclude further economies, and that the balance would increasingly swing toward nuclear energy.

Owen also gave the meeting detailed information on the building of materials-testing reactors which would come into service in 1957–58. He emphasized the need for smaller power reactors for export and transport purposes and felt that these might be gas-cooled types. In an interesting account of the relationship between the various engineering and development groups, he emphasized the need for a correct decision on the most suitable reactor for particular applications and then for ruthless adherence to a suitable construction program.

The question of safety was raised by one member from overseas and was answered at length by Hinton, who outlined the siting policy followed. He felt that a very conservative attitude had been adopted. In the Calder Hall-type of reactor, none of the possible forms of failure could lead to an uncontrolled rise in reactivity, giving runaway conditions. Indeed, no two unrelated major fault conditions occurring simultaneously could give a serious district hazard. In his opinion, this type of reactor introduced an industrial hazard considerably less than many, such as chlorine storage and transport, which were readily accepted by the community.



Comparison of 1954 equivalent capital cost of steam prime movers, land-based oil engines, and the Calder factory.



Ceremonies at Great Britain's Calder Hall Station, 17 Oct. 1956, where Queen Elizabeth opened the world's first full-sized atomic power station by pulling a switch that sent the first atomic-made electricity into the national grid.

In the second session, on "Technical research problems," interest was again concentrated on a few papers. That by Fortescue and Hall, which outlined the experimental work leading to the choice of shape of the Calder Hall fuel element, aroused a good discussion, notably from Saunders (Imperial College). The paper does not purport to be complete, but it is nevertheless an extensive account of the reasons for the high efficiency of the transverse finning adopted in place of the longitudinal fins of the Windscale piles. Photographs illustrating the formation of geared vortices between the fins are particularly interesting in this connection. Both the paper and the resulting discussion indicated that interest in the subject of heat transfer is by no means exhausted, in spite of the large amount of work which has been done, and this conclusion is reinforced by later work on gases, water, and liquid metals.

Schonland (deputy director of the Atomic Energy Research Establishment), although he probably knew the answer, raised the interesting question, in discussion of the physics papers, of whether the expensive experimental work in applied physics could be replaced by theoretical work. There is little doubt that some economy might be effected by simplification of experiment, but this could well lead to additional complication in the mathematics. Mummery felt that a judicious use of experimental techniques was necessary but that this must be combined with adequate development of the academic basis of the work.

Although only two papers were presented on the metallurgical work associated with the Calder Hall development, these were particularly complete, and there is a growing realization of the limitation in reactor design imposed by the materials of construction. In the case of uranium itself, the reactors do not impose severe irradiation levels, since the primary objective is the production of plutonium. The ultimate objective of power production has been kept well in mind, and uranium has been produced by casting and heat treatment by a continuous high-frequency induction method. Great care is taken to give freedom from internal strains and a fine random grain size, which is expected to give a good performance in later reactors. Questions were asked on the creep of uranium and its effects on the suitability of the vertical stacking arrangement used. It was pointed out that this had been extensively studied to eliminate danger on this score. It is well known that, between the opening of Calder Hall and the conference, some cartridges had been dis-

charged from the piles, giving good reason to believe that the work on uranium had led to correct conclusions.

The use of magnesium alloys in high-temperature gas streams had, in the early days, seemed a brave decision. This is clear from the outline of the development work on these materials. The manufacture of the highest quality metal and its forming and welding required much work; a most persistent problem was the low ductility of the alloys in some ranges of temperature. Similarly, magnesium alloys show varying tendencies to form voids at grain boundaries under certain conditions of temperature and stress. The continued use of magnesium alloys in reactors of this type demands confidence in the development work and in experience to date.

The choice of steel for the pressure vessel was referred to in the metallurgical papers, and the construction was described in the first paper of the next session. Both in the papers and in the resulting discussion, it was interesting to note the importance attached to avoidance of the possibility of brittle failure of the vessel. This led to the choice of a steel with a low transition temperature and to a complete x-ray inspection of all welds. Finally the vessel was stress-relieved *in situ* by electric heaters placed inside the vessel and then subjected to both pressure and vacuum tests.

Details are given, in the relevant papers, of the uranium-handling equipment and of the design of important equipment, such as the electric equipment, blowers, and ducting. The optimization of the piles for plutonium production lead to a low gas temperature, and for good thermal efficiency a dual pressure cycle was adopted for the turbines. Improved efficiency will no doubt result from raising the gas temperature in future reactors.

Interesting comments on the session dealing with reactor control and instrumentation came from the manager of the Calder Hall plant, Stretch. Equipment for the detection of faulty fuel elements appears complicated in photographs, although it is found to be simple in operation. The instrument was designed to have greater flexibility than may be found necessary in future reactors. Elsewhere the designers have attempted to limit instruments to an absolute minimum. Stretch felt that later it would be possible to reduce the instrumentation without reducing the flexibility which he had already found in operating the reactors.

The final session of the conference was devoted to a further paper by R. V. Moore on the possibility of developing better reactors of the basic Calder Hall-type. The important point is that steps will be taken to raise the gas temperature. This will mean that the fuel elements must be clad in higher melting-point metals than magnesium or aluminum, with possibly a higher surface-to-mass ratio. This might lead to a need for enriched uranium, with a continuing feed of natural uranium, so that the demand for diffusion plant effort would be small. Alternative coolants and gas-turbine cycles are other possible future steps.

These matters are essentially speculative, but the British effort appears to be firmly based on natural uranium fuel reactors of the gas-cooled, graphite-moderated type typified by Calder Hall. The tone of the conference was undoubtedly one of optimism tempered by a realization of the effort which will be necessary to meet the increasing demand for power. It was generally felt that the release of so much detailed information would help to provide a stimulus to British industry to meet the challenge before it.

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IUPAC Commission on Proteins

A symposium on protein chemistry will be held in Paris, 25–29 July, under the auspices of the Commission on Proteins of the Section of Biological Chemistry, International Union of Pure and Applied Chemistry. The invited speakers and participants in the discussions include A. Tiselius, L. Pauling, C. H. W. Hirs, C. B. Anfinsen, H. Fraenkel-Conrat, G. Schramm, R. R. Porter, C. H. Li, F. Sanger, E. L. Smith, H. Tuppy, L. C. Craig, J. C. Kendrew, C. Tanford, F. Turba, F. Sorm, P. Desnuelle, C. Fromageot, J. L. Oncley, P. Edman, H. Neurath, K. Bailey, K. Linderstrom-Lang, and K. Pedersen.

The program will be devoted to a survey of present knowledge of the structure and biological function of protein molecules. The papers will be published in monograph form. The symposium will be open to about 150 biochemists, who must register *before 1 Apr.* with the chairman of the symposium, Prof. Jean Roche, College de France, Place Marcellin-Berthelot, Paris 5, France.

The concept behind this special symposium on the present state of knowledge of protein structure stems in part from the objectives which led to the creation of the IUPAC Commission on Proteins in 1951, namely, the question of whether internationally available standard samples of proteins might be helpful in chemical and other studies. As an exploratory step toward determining the demand for such samples, the commission is announcing the present availability of a special sample of a single lot of beef insulin.

Designated as crystalline beef insulin, Batch No. 2189, the protein has been tested by Craig's countercurrent distribution method and Porter's chromatographic procedure. Copies of the curves thus obtained are supplied with each sample. The insulin may be obtained by writing to the British Drug Houses Limited, Graham Street, City Road, London, N.1, England. It is packed in 1-gram ampules at £6 ($18) each to cover the cost of manufacture and distribution.

The purpose in making this sample available is to provide a single lot of insulin that different laboratories can use in experiments in which it may be of value to be working with the same protein preparation. If reference samples of this type prove useful to protein chemists, the Commission on Proteins of IUPAC wishes to help to make available other single batches of proteins prepared in as pure a state as is practicable with current methods of commercial processing.

Comments on this program will be welcomed and may be addressed either to the president of the commission, Prof. A. Neuberger, Department of Chemical Pathology, St. Mary's Hospital Medical School, London, W.2, England, or to the secretary, Dr. Stanford Moore, Rockefeller Institute for Medical Research, 66 St. and York Ave., New York 21, N.Y., U.S.A.

International Crop Protection

The fourth International Congress of Crop Protection will be held in Hamburg, Germany, 8–15 Sept. The subjects to be considered include fundamental research, phytotherapy, protection of stored products, crop-protection techniques, plant quarantine, and organization of crop-protection and legal regulations. One-page abstracts of proposed 20-minute papers should be submitted *before 1 Apr.* to the congress office: Biologische Bundesanstalt für Land- und Forstwirtschaft, Messeweg 11/12, Braunschweig, Federal Union of Germany.

National Health Forum

Names of 80 participants appear on the advance program of the 1957 National Health Forum on "Better mental health—challenge to all health services" that is to take place 20–22 Mar. at the Netherland Hilton Hotel in Cincinnati, Ohio. This is the first year that the forum has been held away from New York. The program, which is an invitation to at-

tend the meeting and includes registration blanks, may be obtained from the National Health Council, 1790 Broadway, New York 19, N.Y. The council sponsors the forum each year on behalf of its national organization members, now 52 in number.

Keynote speakers at the opening session will be Harold D. Lasswell, professor of law and political science at Yale University, and Francis J. Braceland, psychiatrist-in-chief at the Institute of Living, Hartford, Conn., and president of the American Psychiatric Association. Braceland is chairman of the 23-member committee that is planning the forum program.

Curricula in the Biological Sciences

The Committee on Educational Policies and its Subcommittee on College Education, units of the Biology Council, Division of Biology and Agriculture, National Academy of Sciences–National Research Council, are sponsoring a Conference on Undergraduate Curricula in the Biological Sciences. The conference, which is supported by a grant from the National Science Foundation, held a first meeting in Washington, D.C., last December, and will finish its deliberations in a session at the University of North Carolina, Chapel Hill, 1–4 Apr. Willis H. Johnson, a member of the subcommittee, is chairman of the conference.

Recognition of the need for a major conference on biological curricula arose, in part, from correspondence and discussion between the Subcommittee on College Education and some 500 American biologists concerning problems confronting undergraduate education as they relate to the biological sciences. Many correspondents emphasized the need for an intensive, critical reexamination of courses and curricula.

The purpose of the conference is to develop a set of principles for guidance in planning biological courses and curricula for future biologists, keeping in view the range of the biological sciences, the knowledge and abilities teachers must help students to develop, and the functional and technical requirements of different disciplines and lines of work which biologists enter. Discussion is being centered around three questions, corresponding to the main levels with which undergraduate education is concerned: (i) What biological knowledge should form part of the experience of all or most college students, regardless of their course of study? (ii) What additional knowledge and experience, in both biological and related fields, is essential, useful, or desirable for all biologists, irrespective of later specialization? (iii) What is the role of the undergraduate college in providing specialized training, and what additional elements are basic in each of the major areas of specialization in biology?

A summary report will be published shortly after the April meeting and distributed widely. A detailed account of the discussions will also be issued later during the year.

The committee has invited the following 17 biologists, representing diverse fields, to participate in the conference: Marston Bates, Julius H. Comroe, Jr., Lincoln Constance, Harriet B. Creighton, Donald R. Griffin, I. C. Gunsalus, James H. Hilton, George H. Kidder, Chester A. Lawson, John A. Moore, Henry J. Oosting, Robert B. Platt, Alfred S. Romer, I. W. Sizer, Carl P. Swanson, S. L. Washburn, and Frits W. Went.

Others attending the conference include L. A. Maynard, chairman, and Frank L. Campbell, executive secretary, of the Division of Biology and Agriculture; Paul A. Weiss, chairman, and Russell B. Stevens, executive secretary, of the Biology Council; Donald B. Anderson of the National Science Foundation; the Committee on Educational Policies, Howard M. Phillips, chairman, H. R. Albrecht, C. H. Bailey, John A. Behnke, Claude S. Chadwick, Thomas S. Hall, Carlyle Jacobsen, Milton O. Lee, and T. S. Painter, members, R. E. Paulson, executive secretary; and the Subcommittee on College Education, Benson E. Ginsburg, Victor A. Greulach, Willis H. Johnson. Because of the importance of their fields for biology, a chemist, a physicist, and a mathematician have also been invited to the second meeting.

ONR Decennial Symposium

The Office of Naval Research symposium on "A decade of basic and applied science in the Navy" that was to take place 26–27 Mar. [*Science* **125**, 203 (1 Feb. 1957)] has now been scheduled for 19–20 Mar.

Nutrition Conference

The Third Annual Nutrition Conference, sponsored by Wayne State University College of Medicine, will be held on 4–5 Apr. Speakers on the general subject "Fats—helpful or harmful" will include John B. Brown, Ohio State University; Fredrick J. Stare, Harvard University; Grace A. Goldsmith, Tulane University; and Ancel Keys, University of Minnesota. Further information may be obtained by writing the Department of Physiological Chemistry, Wayne State University College of Medicine, Detroit 7, Mich.

International Atomic Agency

Vienna has been selected as the site for the first general conference of the International Atomic Energy Agency in a decision taken at the ninth meeting of the 18-nation Preparatory Commission that has been in session at United Nations Headquarters. Although detailed negotiations with the Austrian Government are still under way, the commission has already expressed its appreciation of the Austrian Government's offer to make the necessary facilities available.

The agency's general conference will be made up of all members. It will meet annually, and together with the Board of Governors, it will determine agency policies and the extent of its operations.

The precise date of the first general conference has not yet been set. It cannot be held until a sufficient number of countries ratify the statute of the agency. Eighty nations have signed the statute and are eligible to become initial members of the agency. At its recent meeting, the Preparatory Commission expressed the hope that enough ratifications will be forthcoming in the near future to make it possible to hold the first general conference in 1957.

Teachers Association Meets

"New frontiers for science teachers" is the theme of the fifth national convention of the National Science Teachers Association (National Education Association) that will meet from 20–23 Mar., in Cleveland, Ohio. Headquarters for the sessions will be the Hotel Cleveland.

The opening address will be given by Arthur S. Flemming, director, Office of Defense Mobilization, who will discuss "Elements of National Security." The evening session the same day will feature a talk on "National Security and science teaching" by John H. Fischer of Baltimore, Md., superintendent of schools.

Five leaders in the science and education fields will be the panelists on the Wednesday evening program. They are Leslie W. Knott of the U.S. Public Health Service; M. H. Trytten, director, Office of Scientific Personnel, National Academy of Sciences; Harold Barnett, director of Economic Growth Studies, Resources for the Future, Inc.; T. Keith Glennon, president, Case Institute of Technology; and Charles C. Cole, assistant dean, Columbia College, Columbia University.

The chief speaker at the Thursday (21 Mar.) general session will be I. Bernard Cohen, professor of the history of science, Harvard University, who will consider "The impact of science upon society." Following his talk, there will be three symposia, one on the elementary-

school level, a second on the junior-high-school level, and the third on the senior-high-school and junior-college level.

Friday's (22 Mar.) general session will deal with "New scientific ideas of greatest consequence to science education." The main speakers will be Dennis Flanagan, editor of *Scientific American,* and former AAAS president Paul B. Sears of Yale University.

The annual banquet will be held Friday evening, with Laurence H. Snyder as the speaker. Snyder, who is dean of the Graduate College, University of Oklahoma, and president of the AAAS, will discuss "Science and human values."

A special program has been developed for the convention's final day. It will feature 11 sections dealing with "Classroom instructional materials and demonstrations for science." Including both discussions and demonstrations, these sessions will go into the various science subject-matter fields in both elementary and high schools. Interested teachers who want copies of the convention program or answers to specific queries should write to the National Science Teachers Association, 1201 16 St., NW, Washington 6, D.C.

Apparatus Makers

The 39th annual meeting of the Scientific Apparatus Makers Association is scheduled to take place at the Greenbrier, White Sulphur Springs, W.Va., 27 Apr.–2 May. The list of special speakers includes George W. Crowe, public relations manager, East Coast division, Esso Standard Oil Company; Dexter M. Keezer, vice president of the McGraw-Hill Publishing Company, Inc.; Howard A. Meyerhoff, executive director, Scientific Manpower Commission; and Ross Nichols, vice president of the Weston Electrical Instrument Corporation. Some 300 company representatives will hear these men discuss such topics as, "public and human relations," "the business outlook," "education of professional manpower," and "government contract problems."

SAMA president Henry F. Dever will preside over the 5-day meeting. Dever is president, Brown Instruments Division, Minneapolis-Honeywell Regulator Company.

UNESCO Conference on Radioisotopes

An international scientific conference on the use of radioisotopes in research will be convened by the United Nations Educational, Scientific and Cultural Organization next September in Paris. Preliminary discussions on the scope and organization of the conference took place at a meeting of scientists from eight countries at UNESCO House, Paris, in January. The scientists were Francisco Magalhaes Gomes of Brazil, Charles D. Coryell of the United States, Charles Fisher of France, Tatsuji Hamada of Japan, A. S. Rao of India, Henry Seligman of the United Kingdom, Cestmir Jech of Czechoslovakia, and Victor Vavilov and Ivan Rojansky of the USSR. Observers present from the World Health Organization, the World Meteorological Organization, the Food and Agriculture Organization, and the European Organization for Nuclear Research promised the support of their organizations for the conference.

More than 1000 scientists are expected to attend the conference. The purpose will not be to adopt resolutions or recommendations but to provide a broad exchange of information on newest developments in the use of radioisotopes as instruments of research, as tracers, or as sources of radiation. The conference will work in two main sections, one dealing with radioisotopes in the physical sciences and the second with the biological sciences.

The first section will cover such fields as geology and geophysics (including meteorology and oceanography) and metallurgical and industrial research. The second will take up the use of radioisotopes in biochemistry (including plant biochemistry and photosynthesis), human and animal physiological research, nutrition research, basic medical research, and certain branches of agricultural research, including soil fertility, plant and animal pathology, and the use of insecticides.

Technical Writers' Institute

The fifth annual Technical Writers' Institute will be held at Rensselaer Polytechnic Institute, Troy, N.Y., 10–14 June, under the direction of Jay R. Gould. In the past 4 years 300 representatives of 150 national and international companies have attended the institute, which is designed for those who supervise technical writing in business, industry, and the professions.

The institute includes sessions on manuals and instruction books, reports, technical promotion, training programs, industrial films, and graphic and illustrative aids. Writing sessions will put into practice the more general principles learned through lectures and discussion. Additional information may be obtained by writing to Jay R. Gould, Technical Writers' Institute, Rensselaer Polytechnic Institute, Troy, N.Y.

Society Elections

■ Association for Computing Machinery: pres., John W. Carr III, University of Michigan; v. pres., Richard W. Hamming, Bell Telephone Laboratories; sec., Jack Moshman, Council for Economic and Industry Research, 734 15 St., NW, Washington 5, D.C.; treas., Charles Concordia, General Electric Company. Representative to the AAAS Council is Alston S. Householder.

■ American Meteorological Society: pres., Robert D. Fletcher, Air Weather Service; v. pres., Frederic A. Berry, Advisory Committee on Weather Control; sec., Thomas F. Malone, Travelers Insurance Companies, 700 Main St., Hartford, Conn.; treas., Henry DeC. Ward, Eaton and Howard, Inc. Representative to the AAAS Council is Kenneth C. Spengler.

■ Society for Experimental Stress Analysis: pres., M. M. Leven, Westinghouse Electric Corporation; v. pres., E. Wenk, Jr., Southwest Research Institute; v. pres., W. R. Campbell, General Electric Company; sec.-treas., W. M. Murray, Massachusetts Institute of Technology. Representative to the AAAS Council is Miklos Hetenyi.

Forthcoming Events

April

4–6. Society for Research in Child Development, biennial, Iowa City, Iowa. (L. L. Lovell, Iowa Child Welfare Research Sta., State Univ. of Iowa, Iowa City.)

7–10. Pan American Assoc. of Ophthalmology, 4th interim cong., New York, N.Y. (B. F. Payne, 17 E. 72 St., New York 21.)

7–12. American Chemical Soc., Miami, Fla. (A. H. Emery, ACS, 1155 16 St., NW, Washington 6.)

8. Phi Lambda Upsilon, Miami, Fla. (T. B. Cameron, Dept. of Chemistry, Univ. of Cincinnati, Cincinnati 21, Ohio.)

8–10. American Soc. of Mechanical Engineers, spring, Birmingham, Ala. (C. E. Davies, ASME, 29 W. 39 St., New York 18.)

8–12. Food Bacteriology, internatl. symp., Cambridge, England. (Dr. Mossel, Central Inst. for Nutrition Research T.N.O., Catharijnesingel 61, Utrecht, Netherlands.)

8–12. Surface Activity, 2nd world cong., London, England. (Congress Secy., 14 Belgrave Sq., London, S.W. 1.)

9–10. Industrial Electronics Education Conf., annual, Chicago, Ill. (E. A. Roberts, Armour Research Foundation, Illinois Inst. of Technology, Chicago 16.)

10–12. Nuclear Instrumentation Conf., natl., Atlanta, Ga. (H. Kindler, Instrument Soc. of America, 313 Sixth Ave., Pittsburgh, Pa.)

10–13. Conference on Embryology and Experimental Morphology, Cambridge, England. (D. R. Newth, Dept. of Zoology, University College London, Gower St., London W.C. 1.)

11–13. American Assoc. of Pathologists and Bacteriologists, annual, Washington D.C. (E. A. Gall, Cincinnati General Hospital, Cincinnati 29, Ohio.)

11–13. Southwestern Inst. of Radio Engineers Conf. and Electronics Show, 9th annual, with 2nd National Simulation Conf., Houston, Tex. (F. C. Smith, Jr., Box 13058, Houston 19.)

12–13. Colorado–Wyoming Acad. of Science, annual, Fort Collins, Colo. (O. W. Olsen, Colorado A.&M. College, Fort Collins.)

12–13. Eastern Psychological Assoc., annual, New York, N.Y. (G. G. Lane, Dept. of Psychology, Univ. of Delaware, Newark.)

12–13. New Orleans Acad. of Sciences, New Orleans, La. (A. Welden, Dept. of Biology, Newcomb College, New Orleans.)

12–14. American Assoc. for Cancer Research, Chicago, Ill. (H. J. Creech, Inst. for Cancer Research, Fox Chase, Philadelphia 11, Pa.)

12–14. American Assoc. of Physical Anthropologists, annual, Ann Arbor, Mich. (J. H. Spuhler, Dept. of Human Genetics, Univ. of Michigan Medical School, Ann Arbor.)

12–14. American Soc. of Human Genetics, annual, Ann Arbor, Mich. (E. J. Gardner, Dept. of Zoology, Utah State College, Logan.)

12–14. National Speleological Soc., Natural Bridge, Va. (Mrs. M. McKenzie, 1407 Hickory Ct., Broyhill Park, Falls Church, Va.)

13. Society for the Scientific Study of Religion, spring, New York, N.Y. (W. C. Clark, Hartford School of Religious Education, Hartford 5, Conn.)

13. South Carolina Academy of Science, annual, Columbia (Miss M. Hess, Box 114, Winthrop College, Rock Hill, S.C.)

14–16. Telemetering Symposium, natl., Philadelphia, Pa. (A. S. Westneat, Jr., Applied Science Corp., Box 44, Princeton, N.J.)

14–20. American Physiological Soc., Chicago, Ill. (M. O. Lee, APS, 9650 Wisconsin Ave., NW, Washington 14.)

15–17. American Soc. of Lubrication Engineers, annual, Detroit, Mich. (W. P. Youngclaus, Jr., ASLE, 84 E. Randolph St., Chicago 1, Ill.)

15–17. Molecular Mechanism of Rate Processes in Solids, Faraday Soc. discussion, Amsterdam, Netherlands. (Faraday Soc., 6 Gray's Inn Sq., London, W.C.1.)

15–17. Systems for Information Retrieval, symp., Cleveland, Ohio. (J. H. Shera, School of Library Science, Western Reserve Univ., Cleveland 6.)

15–18. American Personnel and Guidance Assoc. and constituent divisions: American College Personnel Assoc., American School Counselor Assoc., National Assoc. of Guidance Supervisors and Counselor Trainers, National Vocational Guidance Assoc., Student Personnel Assoc. for Teacher Education; Detroit, Mich. (A. A. Hitchcock, APGA, 1534 O St., NW, Washington 5.)

15–18. Host-Specificity and Parallel Evolution among Parasitic Insects and Worms, symp., Neuchatel, Switzerland. (J. G. Baer, C.P. 2, Neuchatel 7.)

15–18. International Inst. of Differing Civilizations, 30th session, Lisbon, Portugal. (11, Blvd. de Waterloo, Brussels, Belgium.)

15–19. American Assoc. of Immunologists, annual, Chicago, Ill. (F. S. Cheever, Graduate School of Public Health, Univ. of Pittsburgh, Pittsburgh 13, Pa.)

15–19. American Soc. for Experimental Pathology, annual, Chicago, Ill. (C. C. Erickson, Inst. of Pathology, Univ. of Tennessee, 858 Madison Ave., Memphis.)

15–19. American Soc. for Pharmacology and Experimental Therapeutics, Chicago, Ill. (H. Hodge, Dept. of Pharmacology, Univ. of Rochester, Rochester, N.Y.)

15–19. Federation of American Societies for Experimental Biology, annual, Chicago, Ill. (M. O. Lee, FASEB, 9650 Wisconsin Ave., Washington 14.)

15–19. High Energy Nuclear Physics Conf., 7th annual, Rochester, N.Y. (R., Marshak, Univ. of Rochester, Rochester.)

15–20. American Inst. of Nutrition, annual, Chicago, Ill. (R. W. Engel, Dept. of Biochemistry and Nutrition, Virginia Polytechnic Inst., Blacksburg 13, Va.)

16–18. Nuclear Tests for Nondestructive Testing Applications, symp., Chicago, Ill. (American Soc. for Testing Materials, 1916 Race St., Philadelphia 3, Pa.)

17–19. American Assoc. of Anatomists, annual, Baltimore, Md. (L. B. Flexner, School of Medicine, Univ. of Pennsylvania, Philadelphia 4.)

18–20. Assoc. of Southeastern Biologists, annual, Athens, Ga. (J. C. Dickinson, Jr., Univ. of Florida, Gainesville.)

18–20. Ohio Acad. of Science, annual. Bowling Green. (R. W. Dexter, Dept. of Biology, Kent State Univ., Kent, Ohio.)

18–20. Southern Soc. for Philosophy and Psychology, annual, Gatlinburg. Tenn. (W. B. Webb, U.S. Navy School of Aviation Medicine, Pensacola, Fla.)

18–20. Venereal Disease Postgrad. Conf., 26th, Memphis, Tenn. (H. Packer, Dept. of Preventive Medicine, Univ. of Tennessee College of Medicine, Memphis 3.)

18–21. American Soc. of Ichthyologists and Herpetologists, 37th annual, New Orleans, La. (F. R. Cagle, Dept. of Zoology, Tulane Univ., New Orleans 18.)

19–20. Arkansas Acad. of Science, annual, Fayetteville. (L. F. Bailey, University of Arkansas, Fayetteville.)

19–20. Seismological Soc. of America, annual, Los Angeles, Calif. (P. Byerly, Bacon Hall, Univ. of California, Berkeley 4.)

20–26. Industrial Health Conf., 12th natl., St. Louis, Mo. (E. C. Holmblad, Industrial Medical Assoc., 28 E. Jackson Blvd., Chicago 4, Ill.)

22–24. National Acad. of Sciences, annual, Washington, D.C. (H. L. Dryden, NAS, 2101 Constitution Ave., NW, Washington 25.)

(See issue of 15 February for comprehensive list)

LETTERS

The editors take no responsibility for the content of the letters published in this section. Anonymous letters will not be considered. Letters intended for publication should be typewritten double-spaced and submitted in duplicate. A letter writer should indicate clearly whether or not his letter is submitted for publication. For additional information, see Science **124**, *249 (1956) and* **125**, *16 (4 Jan. 1957).*

Diffraction Patterns

A recent news note in *Science* [**125**, 109 (18 Jan. 1957)] reported a new method of investigating diffraction patterns as a function of time. The method had been described in an article by R. Thun [*Umschau* **56**, 660 (1 Nov. 1956); **56**, 688 (15 Nov. 1956)]. It may be of interest that just recently a still better method serving a similar purpose has been disclosed.

H. Nielsen, in *Photographie und Wissenschaft* **5**, 3 (1956), shows x-ray diffraction patterns taken continuously from tantalite crystals when subjected to heat. Different photographs are printed separately, using colored light and color-sensitive photographic paper, in a manner similar to Land's color-translation process [*Science* **109**, 371 (15 Apr. 1949)]. On the final x-ray diffraction photographs, it can easily be seen that changes occurring during the photographic exposure yield different colors Unlike the results with Boettcher and Thun's method, these x-ray diffraction patterns retain a three-dimensional shape.

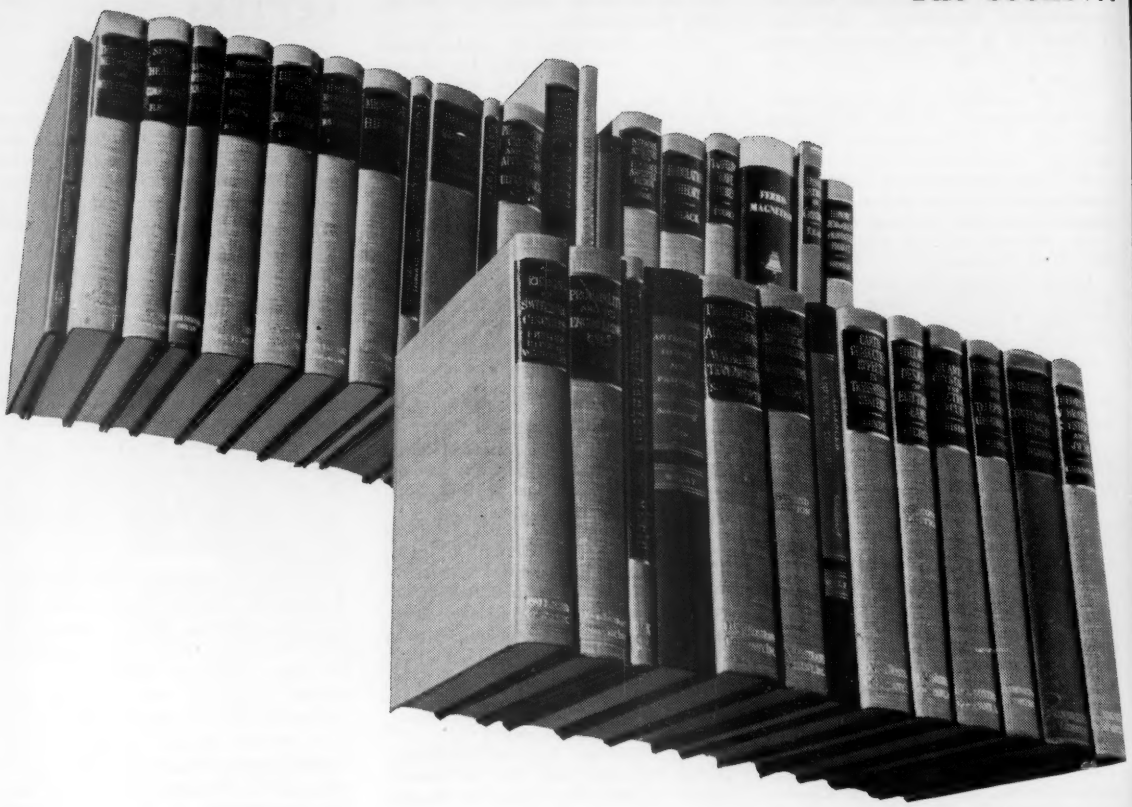
J. B. MEYER-ARENDT
Ohio State University, Columbus

Biology of Schizophrenia

M. K. Horwitt [Science **124**, 429 (1956)] apparently finds little fact and much artifact in many current reports concerning differences between schizophrenic and nonschizophrenic individuals. Certainly uncontrolled studies that neglect the variables cited shed little light on the problem.

However, some of the remedies suggested for converting artifact to fact appear to be of doubtful significance. This arises mainly from a common misinterpretation or delusion shared by many psychiatrists which may have induced in the author a bit of *folie à deux*. He states: "Much of this conflict is due to a lack of understanding by some workers that the term *schizophrenia* is a general classification with many subdivisions, which are often only slightly related, and that the manner in which the patient chooses to

The books...



How the scientific world shares in fruits of the telephone art

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Harold S. Black, B.S. in E.E., Worcester Polytechnic Inst., author of "Modulation Theory."

John R. Pierce, Ph.D., California Inst. of Tech., author of "Traveling-Wave Tubes."

Richard M. Bozorth, Ph.D., California Inst. of Tech., author of "Ferromagnetism."

W. Thornton Read, M.S., Brown University, author of "Dislocations in Crystals."

Hendrik W. Bode, Ph.D., Columbia University, author of "Network Analysis and Feedback Amplifier Design."

Walter A. Shewhart, Ph.D., University of California, author of "Economic Control of Quality of Manufactured Product."

manifest his difficulties may not be a function of his physiological status." Certainly in psychiatry there is a wide divergence of opinion whether schizophrenia is a single entity or whether it is a disease characterized by the uniqueness of the individual or a reaction formation. To the psychiatrist, each patient is unique. But this has little bearing on the problem whether a single biochemical factor is present.

Horwitt has recognized this by his statement that it "may not" be a function of his physiological status—conversely it "may." In medicine, it is not at all unusual to find that diseases with fairly simple biochemical defects express themselves in terms of personality in unique ways. I am convinced that, if the factors of hyperthyroidism were unknown today, we would argue about it in the same way. During the latter part of the last century, there were many passionate arguments regarding the causes of paresis.

I am disturbed at the expression "the patient chooses to manifest." This implies again the entire concept of reaction formation with subconscious selection of the type of reaction. Apparently, Horwitt uses psychiatric hypothesis as fact when it may in fact be artifact [P. Bailey, *Am. J. Psychiat.* **113**, 387 (1956)].

The first recommendation that estimation of tension and anxiety be made would be useful if this were possible. I have searched in vain for a test that will reliably measure this variable. One can often decide whether a person is anxious or not. To quantify this will be a major achievement. To ask one to measure a variable without telling him which measure to use is the counsel of futility. The second recommendation, that no research be done until patients have balanced at least 3 months, removes pretty effectively from biochemistry the vast majority of acute schizophrenics, leaving a residue of chronic hospitalized patients. Perhaps this is desirable, but one should know clearly the result of one's recommendation.

Finally, regarding urine collections, overnight samples from patients and controls may lead to erroneous conclusions. I fear that 24-hour samples will do the same. One ought to combine the best of both methods and make measurements on urine collected at given intervals over the 24-hour period.

Finally, in contrast to Horwitt's, it is my belief that psychiatrists use too freely the concept of cause and effect and that biochemists usually are not preoccupied with these matters. This falls within the realm of philosophy. Writing about Galileo, Newman states: "As we read his writings we instinctively feel at home: we know that we have reached the method of physical science which is still in use. Galileo's primary interest was to discover 'how' rather than 'why' things work" [J. R. Newman, *The World of Mathematics* (Simon and Schuster, New York, 1956), vol. 2, p. 726]. Science deals with the rational explanation of observable phenomena. In the area of schizophrenia, it is of no utility to discover what may be the cause—there are undoubtedly many "causes." We are concerned with the factors that transform a set of causes into a set of clinical symptoms and signs. In medicine, we do not treat causes—we treat those variables most easily modified, and these may be physiological, psychological, electric, or combinations of these.

The paper by Horwitt will make many biochemists aware of controllable factors which they should have learned in college. But the biochemist must not be seduced by analytic dogma that depends solely on the word of the master. In psychiatry today we need more of the cold breath of reason.

A. HOFFER

University Hospital, Saskatoon, Saskatchewan

I am pleased by A. Hoffer's reaction to my article "Fact and artifact in the biology of schizophrenia"; after 20 years of close association with psychiatrists and their patients, one learns to recognize defensive reactions.

As for the particulars with which Hoffer chose to disagree, I am sure that they are less important than the generalization that too many papers are published in this field which do not meet the accepted standards of the scientific method. It is time that some biologists (including psychiatrists attempting to be biochemists and biochemists attempting to be psychiatrists) stop beclouding the literature with reports of poorly controlled experiments that often catalyze extensive and expensive reinvestigations, because the factors of stress, nutritional state, relative physical activity, and of liver function are not controlled. Some day it will be possible to differentiate with greater accuracy the stresses of schizophrenia from those of other diseases by means of biochemistry. This day will come sooner if we improve our methods of controlling the variables under discussion.

M. K. HORWITT

Elgin State Hospital, Elgin, Illinois

No Visa Difficulties

In confirmation of Walter M. Rudolph's letter to Thomas J. Killian, quoted in the editorial "Scotching a damaging rumor" [*Science* **125**, 7 (4 Jan. 1957)], I should like to report that at least six (Western) European scientists who had made one or more visits to Rus-

sia or the satellite countries during 1954 and 1955 were admitted to our country in August 1956 to attend the meetings of the sixth Congress of the International Society of Hematology. These six individuals had all been concerned regarding possible difficulty in obtaining visas for our country, but no such difficulties materialized. The various people in the State Department (including Rudolph) were very helpful. The entrance of these and of 17 "Iron Curtain" delegates was facilitated by recourse to the Exchange Visitors Program, a mechanism which seems to be of considerable value for the entrance of foreign scientists to our country for international gatherings.

WILLIAM DAMESHEK
New England Center Hospital, Boston, Massachusetts

EQUIPMENT NEWS

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Science *does not assume responsibility for the accuracy of the information. All inquiries concerning items listed should be addressed to* Science, *Room 740, 11 W. 42 St., New York 36, N.Y. Include the name(s) of the manufacturer(s) and the department number(s).*

■ BOTTLE ROTATOR-OSCILLATOR accommodates 20 32-oz test bottles simultaneously. The unit measures 49 by 10 by 14 in. and weighs 75 lb. Bottles are held in place by individually hinged, spring-loaded clips. One model oscillates through 90 deg; another through 360 deg. (Labline, Inc., Dept. S196)

■ AREA MONITOR incorporating a 3-cycle logarithmic count-rate meter is available with either a beta-gamma sensitive GM probe or with a gamma-sensitive scintillation probe. Visual and audible alarms are provided. A calibrated radioactive test sample and a 3600 cy/min test signal are included. Range is 50 to 50,000 count/min. (Nuclear Measurements Corp., Dept. S170)

■ RECORDING ELLIPSOMETER permits the measurement and recording of changes of thickness of very thin transparent films on a flat metal mirror. The instrument is based on the functional relationship between ellipticity of reflected polarized light and the thickness of the film. Monomolecular layers may be studied in this way. Sensitivity is better than 0.5 A in the most sensitive thickness range. For materials of refractive index near 1.5, this range is at a thickness of approximately 1000 A. To bring observations into this range, the metal reflecting surface is first coated with a suitable background material. (O. C. Rudolph and Sons, Dept. S175)

■ *p*H METER model 85 is a line-operated instrument said to have an accuracy of 0.1 *p*H unit. Range is 0 to 14 without switching. Either a combination glass and calomel electrode or separate electrodes are furnished. (Photovolt Corp., Dept. S187)

■ SURFACE TEMPERATURE is measured by a tape-resistor temperature-sensing element, 1/4 in. by 5/16 in., which is applied by pressing onto the surface. These resistors, available in ranges from −300° to 400°F, furnish up to 5 v output without amplification. Accuracy is ±2 percent of full scale, and precision is ±0.5 percent of full scale. (Trans-Sonics, Inc., Dept. S178)

■ ORGANIC CHEMICALS made by Matheson, Coleman and Bell and available for immediate delivery are listed in a catalog. (Chicago Apparatus Co., Dept. S179)

■ MAXIMUM-MINIMUM THERMOMETERS of stainless steel are of direct-drive, bimetallic type. Two ancillary pointers that can be set against the high and low sides of the indicating pointer move with the pointer in each direction, remaining at the maximum and minimum readings until reset. The setting knob is hermetically sealed through the glass window. (Pacific Transducer Corp., Dept. S182)

■ VACUUM FURNACE can be used for melting, annealing, brazing, sintering, and degassing. The model F-1212 accommodates a 3- by 6-in. zirconia crucible and provides temperatures to 2000°C. The vacuum system includes a

4-in., 320-lit/sec diffusion pump with a liquid-nitrogen cold trap. A combination thermocouple-ionization gage measures the vacuum. (High Vacuum Equipment Corp., Dept. S184)

■ STEREO MICROSCOPE uses 8× Kellner eyepieces and two sets of objectives on a revolving turret to provide magnifications of 21 and 34. Working distance is up to 3 in. (Edmund Scientific Co., Dept. S181)

■ ISOLATED WORK SPACE 3 ft long, 2 ft high, and 28 in. deep is provided by a chamber that has its own air supply, exhaust system, and services. Unit can be used closed or open. (Fisher Scientific Co., Dept. S183)

■ POWER SUPPLY for transistor work furnishes 0 to 50 v d-c (continuously variable) at current of 0 to 1000 ma, as well as 6.3 v a-c at 10 amp. Change of input voltage from 105 to 125 v results in 0.1 percent change in output voltage. Ripple is 3 mv r.m.s. for 50 v, 1000 ma output, and regulation at the same output is 80 mv, no load to full load. Output voltage is set by a three-turn Helipot. (Dressen-Barnes Corp., Dept. S185)

■ NEEDLE CLEANER cleans 1 to 36 needles collected from used Vacutainers. Connection to filter pump draws detergent, water, and disinfectant through needles. (American Hospital Supply Corp., Dept. S186)

■ ACTIVITY METER for quantitative recording of motor activity in rats and mice consists of a photoelectric sensing chamber that operates a remote counting unit for registering the animal's movements. (Metro Industries, Dept. S188)

■ GLASS FRACTIONATING COLUMNS and auxiliaries are described in an 8-page catalog. (Glass Engineering Laboratories, Dept. S190)

■ GAS STERILIZER uses a mixture of ethylene oxide, carbon dioxide, and water vapor to sterilize temperature-sensitive objects. Gas is introduced after evacuation of sterilization chamber and is removed by evacuation. Factors of time, temperature, humidity, and gas concentration are automatically controlled. A typical cycle is 4 hr at 130°F. (Wilmot Castle Co., Dept. S191)

■ RECORDER permits 400 linear inches of on-off information to be noted on a 6- by 14-in. chart. The record is made as a spiral trace on a drum-supported, wax-paper chart. Drum periods from 4 min to 24 hr can be furnished. (Gorrell and Gorrell, Dept. S193)

JOSHUA STERN
National Bureau of Standards

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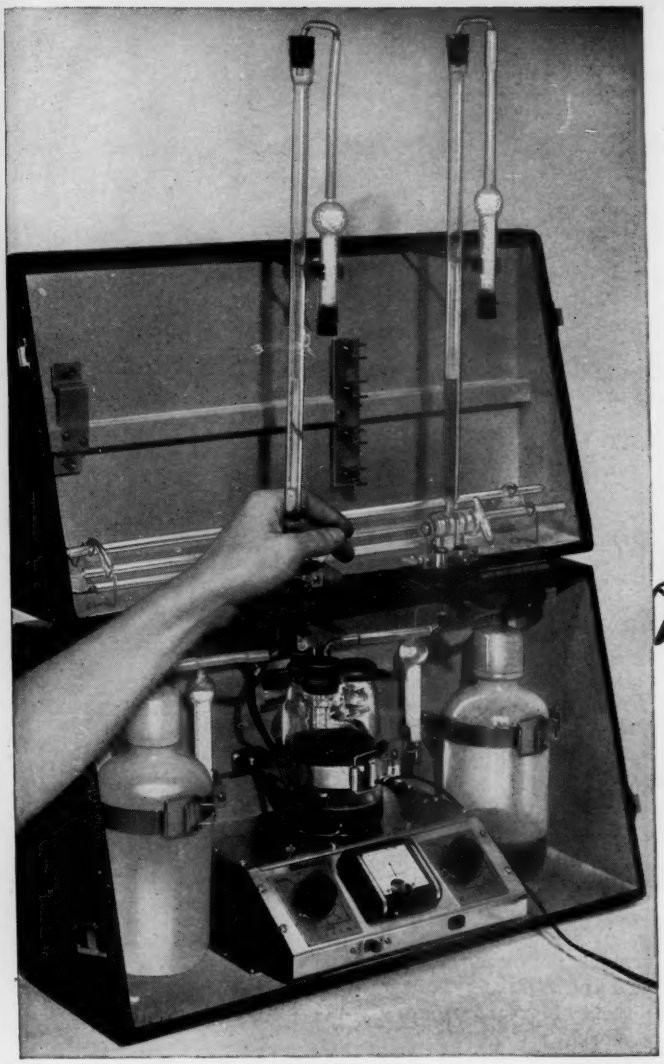

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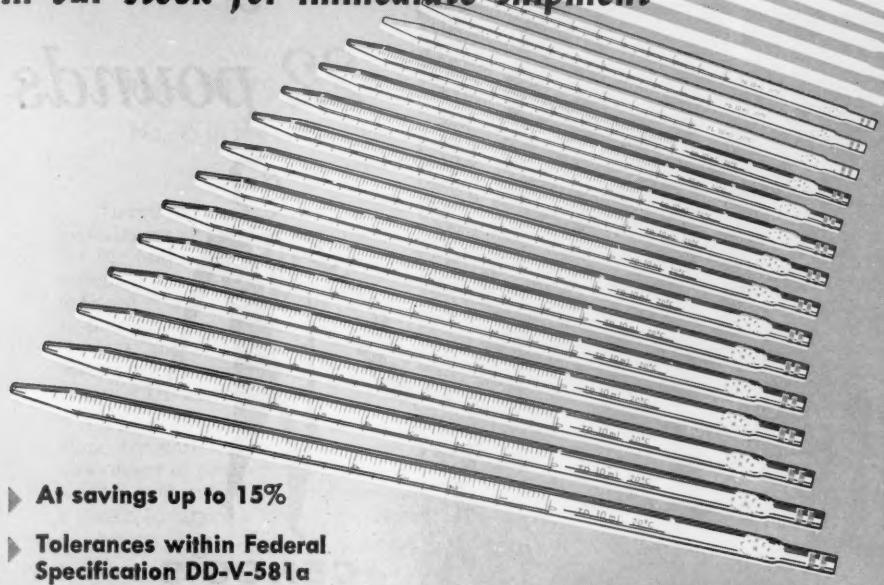

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